POWER

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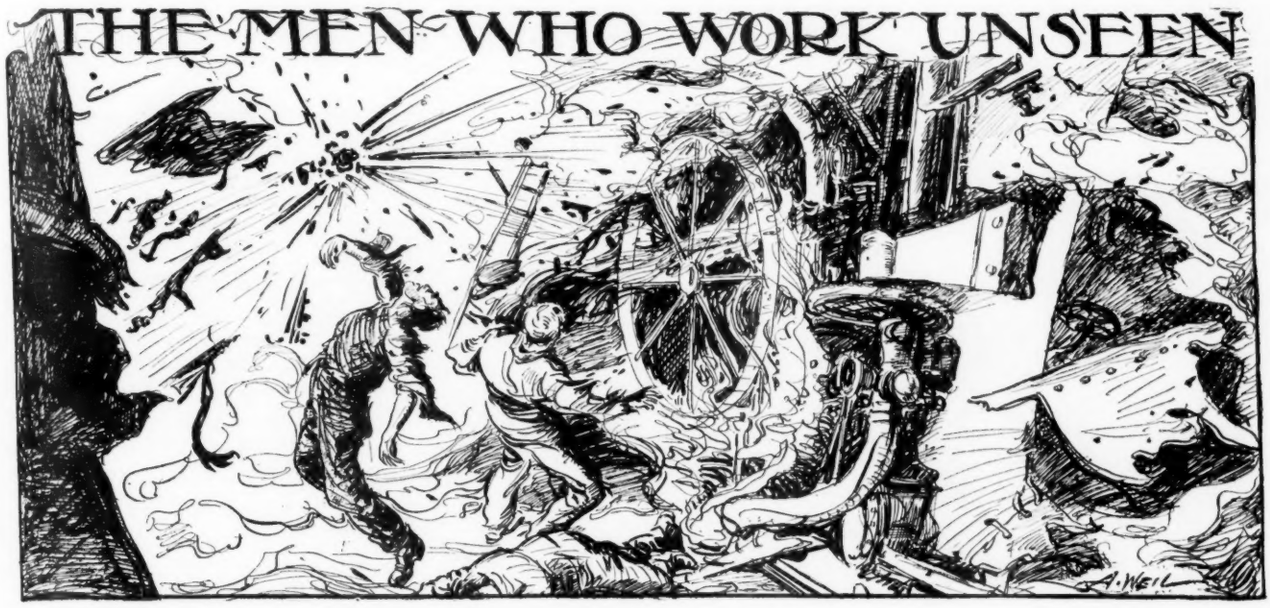
THE MEN WHO WORK UNSEEN



The power that turns the night to day,
That drives the wheels in workshops gray,
And brings the ships into the bay,
  Is wrought by human hands.
In stifling rooms, away from sight,
Amid the dirt, from morn till night,
Men stoop to labor with their might,
  Fulfilling all demands.

They sweat and grind, fall ill and die,
And others come, as time goes by,
To labor on, without a sigh,
  Parts of a great machine.
No cheers are theirs, no flags are flung,
Their splendid courage is unsung,
Their names are not on every tongue,
  These men who work unseen.

The fireman and the engineer
On ocean vessels, without fear,
Beneath the decks, though foes are near,
  Work calmly every day;
They brave the submarine's quick blow,
Which oft brings death to those below;
There is no honor we bestow
  Too great for such as they.

We laud the soldier as he stands
On battlefields in foreign lands,
The sailor, who, within his hands
  Our safety holds this hour;
But as we sing our hymns of praise,
We'll not forget those who always
Work on, afar from human gaze—
  The men who make the power.

—By Frank Dorrance Hopley

Maintenance of a Proper Heat Balance

By R. N. EHRHART

This article describes hand and automatic control of exhaust steam from auxiliaries so that the quantity of exhaust steam available for feed heating may at all times be proportional to the load on the main units, thus preventing waste of exhaust at light loads.

IN POWER plants of moderate size there are few problems more vexing than the maintenance of a proper heat balance; that is, the establishment of some method whereby just a sufficient amount of exhaust steam is supplied by the auxiliaries to heat the feed water up to the maximum practicable temperature.

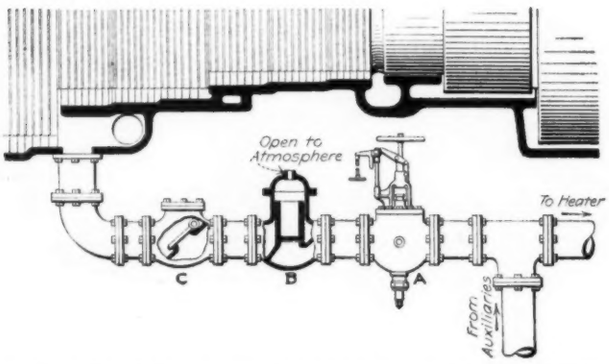


FIG. 1. ARRANGEMENT TO BLEED STEAM INTO TURBINE

The majority of such plants do not use economizers and depend almost entirely on the exhaust steam from the auxiliaries to heat the feed water. The steam consumption of any particular set of auxiliaries is more or less constant, irrespective of the load on the main generating unit, so that while the auxiliaries may supply the proper amount of steam at full load, there will be an excess at lighter loads. In most cases this excess is wasted, being discharged to the atmosphere from the heater exhaust. It is furthermore a fact that the heat balance in most plants is correct only at approximately full load on the main generating units, and as there are few plants that can continuously maintain this full-load condition, the general tendency is toward the waste of a certain amount of exhaust steam except at the maximum-load period.

There are several methods of overcoming these troubles, some of them partly effective, some subject to manual control, and others absolutely automatic and direct in their method of application. An effort is made in the following description to illustrate briefly the various methods.

By driving some of the auxiliaries with motors and others with steam apparatus, it is possible to have the exhaust steam so low that it will not be in excess even at fractional loads. On the other hand, there will be a deficit of steam at heavy loads, so that this method is only partly successful.

If the main turbine is so designed that steam can be introduced or taken out at points where the proper pressure exists, a very satisfactory regulation of exhaust steam is possible. Consider first the case of bleeding steam into the turbine. If the amount of exhaust steam is excessive at light loads, it is possible to discharge the excess steam from the auxiliaries into the low-pressure element of the main generating turbine. There is, however, an element of danger in this, unless proper provisions are made to overcome it. Suppose the circuit-breaker on the main unit went out, throwing the load off. The auxiliaries would pour steam into the low-pressure element of the turbine, and even though the governor admission valve on the main turbine might close, the auxiliaries could conceivably put enough steam into the turbine to bring it up to a dangerous speed; therefore, a control valve in connection with the governor on the main turbine must be placed in the steam line introducing the auxiliary exhaust, so that an excessive speed cannot be reached.

Fig. 1 diagrammatically shows the general method of applying this scheme. The valve *A* is under control of the main or emergency governor of the turbine. The valve *B* is a constant-pressure valve, the function of which is always to maintain slightly more than atmospheric pressure on the auxiliaries, so that vacuum can never be carried back to the complicated piping,

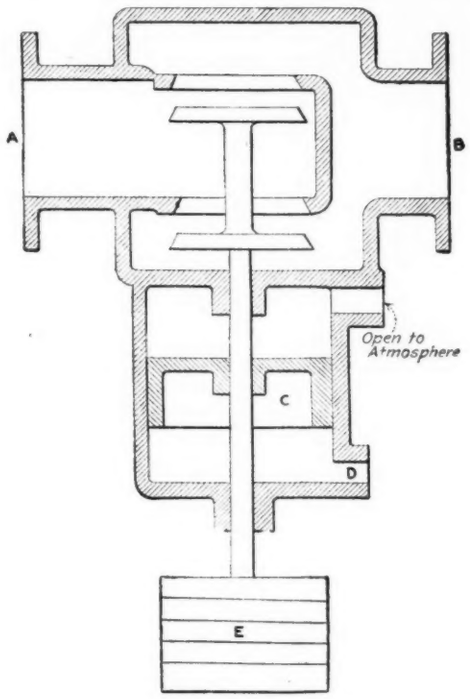


FIG. 2. VALVE CONTROLLING THE BLEEDING OF STEAM OUT OF TURBINE

etc., of the multiple auxiliaries and heater. The plunger or disk of this valve is subjected on its upper side to atmospheric pressure and has a definite weight, so that, for a balance of pressures, the pressure under the seat or on the auxiliaries must always be slightly above that of the atmosphere. The check valve *C* prevents the wholesale flow of steam into the heater, when the load and consequently the pressure builds up in the low-pressure element of the turbine.

The constant-pressure valve *B* is commercially manufactured, and it can also be had with the governor valve *A* incorporated, suitable for connection to certain types of turbines.

It is seen that the scheme, as shown in Fig. 1, will permit, in a practicable way, of making use of an excess of exhaust steam at light loads by bleeding it into the low-pressure element of the turbine, where it can do useful work. That is, as soon as the pressure in the heater materially exceeds that of the atmosphere, steam will escape into the low-pressure element of the turbine. Of course the valve *B* can be weighted so that any desired maximum pressure can be obtained in the heater before steam is discharged into the turbine.

The arrangement shown in Fig. 1 will provide for the excess steam by allowing it to escape into the turbine. It is conceivable, however, that there might be a deficit of exhaust steam, under which condition it would be desirable to bleed steam out of the turbine. Such a condition might exist at very heavy loads. By connecting to the turbine at a point where the pressure is well above atmosphere, this can be accomplished by the use of a valve like that shown in section in Fig. 2. Steam from the turbine is admitted at *A* and issues from the valve at *B*. The upper side of the piston *C* is subjected to atmospheric pressure, and the lower side is subjected to the heater pressure by a pipe connection at *D*. Then, by varying the weights *E* the valve can be made to close at any desired pressure above that of the atmosphere. In other words, as soon as the amount of steam in the heater becomes excessive, with a consequent rise in pressure, the valve will be closed by the pressure under the piston *C*. As in Fig. 1, this valve should be under governor control.

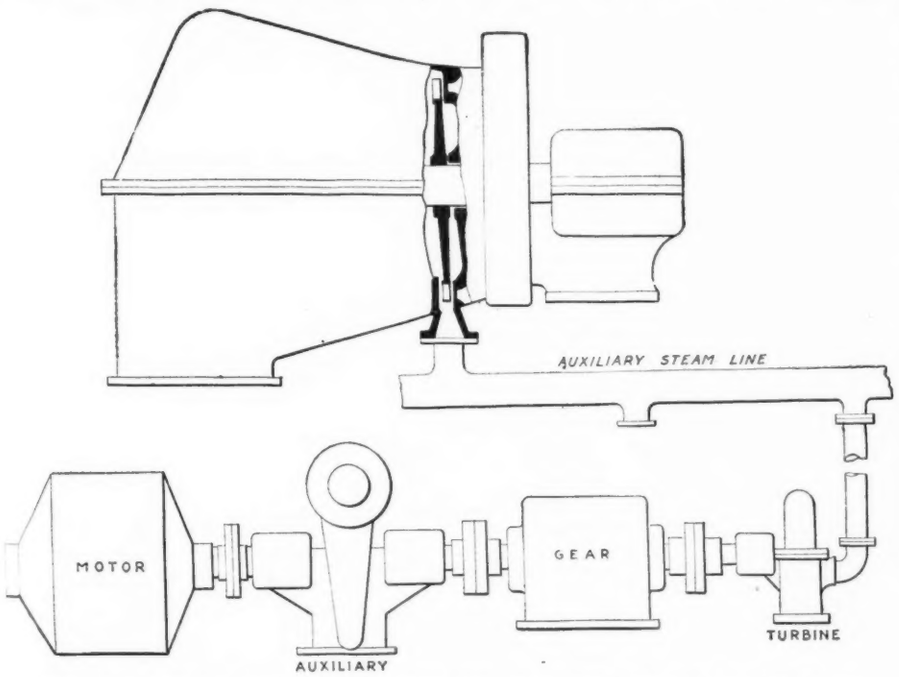


FIG. 3. ARRANGEMENT TO REGULATE FLOW OF AUXILIARY STEAM IN PROPORTION TO REQUIREMENTS

Figs. 1 and 2 show how steam may be bled either into or out of the turbine, depending on the heater pressure, and it is evident that both schemes can be applied to the same turbine. It is of further interest to note that one turbine manufacturer has very ingeniously combined the constant-pressure valve in Fig. 1 with the valve in Fig. 2, as well as an arrangement to keep them both under governor control. The objection may be raised that these valves are complicated and that there are great chances for them to stick or rust in a given position; but practical operation has shown that they function extraordinarily well.

Nearly all auxiliaries, such as circulating pumps, hydraulic air pumps, condensate and boiler-feed pumps, exciters, etc., are commercially available for direct connection to induction motors. The geared turbine has been so well perfected that it is available today for connection to auxiliaries operating at induction-motor speeds. If each of the auxiliaries, or at least the larger ones, is driven by both a geared turbine and a direct-connected motor, there is a means of regulating at will the amount of exhaust steam from the auxiliaries. The most generally used method is to have a double shaft extension on the auxiliary. To one end of the shaft the induction motor is connected and to the other a geared turbine. The governor on the turbine is set so as to maintain the outfit at the synchronous speed of the motor; that is, at practically the speed at which the motor runs when unloaded. Under such conditions, with a full head of steam on the turbine, the motor would develop no power, and therefore require a negligible amount of electric energy.

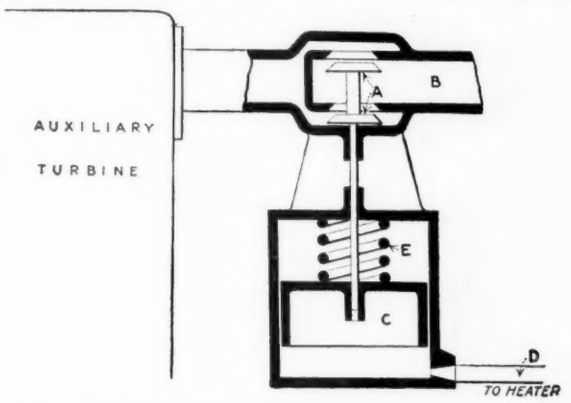


FIG. 4. REGULATING STEAM ADMISSION TO AUXILIARY TURBINE BY PRESSURE IN HEATER

Now, if it is desired to reduce the steam consumption of the turbine, all that is necessary is to close the throttle partly or readjust the governor to lower the speed of the turbine slightly. This lowering of the speed will automatically cause the motor to pick up the portion of the load dropped by the turbine. A diminution of speed of from 3 to 4 per cent. will make the

motor take the full load of the combination, or correspondingly decrease the steam consumption of the turbine to practically nothing. This scheme has frequently been used successfully, but it requires manual adjustment; that is, if more steam is wanted, the turbine is speeded up slightly, and if less, it is slowed down. As already stated, a speed change of from 3 to 4 per cent. will totally load or unload the turbine.

Regulating the Flow of Auxiliary Steam in Proportion to Requirements

In order to accomplish the same results simply and automatically, the writer has devised a method for causing the steam-driven auxiliaries to use an amount of steam almost in direct proportion to the amount passing through the main turbine. Obviously, such an arrangement would give a correct heat balance, since once properly balanced it is evident that it will be maintained; if twice as much steam was passing through the main turbine, it is obvious that approximately twice as much exhaust steam would be needed to heat the resulting feed water.

It is a well-known fact that, at a point in the main-turbine casing immediately following the inlet valve or valves, the pressure will vary almost in proportion to the amount of steam flowing. So, if this point is used as the source of supply for the auxiliary steam, the pressure in this auxiliary line will vary in direct ratio with the steam flow. Consequently, if the auxiliary turbines have no other governor or throttling device than an emergency or runaway governor, the flow through these small turbines will vary directly as the pressure and flow through the main turbine.

With such an arrangement as that shown in Fig. 3, the flow of auxiliary steam will be in direct proportion to the requirements. The motor will of course carry the load when insufficient steam is supplied to the auxiliary turbine and will automatically be relieved of load when the auxiliary turbine is supplied with sufficient steam to carry the load. It will be seen that the automatic regulation of the exhaust steam is accomplished without the aid of any complicated mechanical means whatever.

Regulating Steam Admission to Auxiliary Turbine by Pressure in Heater

Another method devised by the writer, but not yet put into actual operation, is to regulate the steam admission to the auxiliary turbines by the pressure in the heater; this arrangement of course applies to the combined steam and electric drive. Fig. 4 diagrammatically shows this proposed arrangement. A governor valve *A* is placed in the steam line *B* and is operated by a piston *C*. A connection *D* is carried to the heater from below the piston *C*. The relief valve on the heater may be loaded to any desirable pressure, say 5 lb. above atmosphere. The valve *A* would normally be held open by the spring *E* and the weight of the piston *C*. The spring would then be adjusted so that the valve *A* would be closed with a pressure slightly less than that for which the heater relief valve is loaded.

As long as there was no excess of exhaust steam, the heater pressure would hold the valve open. However, as soon as there was an excess of exhaust steam, the heater pressure would rise, eventually shutting the valve *A* and thereby diminishing the steam to the driving turbine, under which circumstance the motor would automatically take the load.

The foregoing is a description of some of the methods used in getting a satisfactory heat balance, but of course there are many other solutions of this problem. The suggestions just given embody some of the later thoughts on this importance subject.

"Stack Gun" for Cleaning Chimneys

In many industrial plants the smoke-stacks become clogged with soot. It is necessary, in order to maintain draft, that they be frequently cleaned. A simple, economical and efficient method to accomplish this is to "shoot" the stack with the "stack gun" and FFF (du Pont) blasting powder. This gun can be used in cleaning either lined or unlined brick or steel stacks without possibility of injury to either the stack or the lining.

The gun can be made of an old pice of shafting about 4 in. in diameter and 14 to 16 in. long. Bore a hole $1\frac{3}{4}$ in. in diameter and 10 in. long in the center of the piece. Then bore a small horizontal hole $\frac{1}{4}$ in. in diameter through the piece to the bottom of the center bore. This hole serves as a touch-hole for inserting the fuse. The gun can then be mounted on a pedestal about 6 in. in diameter, so that it will stand in an upright position.

The method of operation is as follows: Pour FFF blasting powder into the mouth of the cannon to about two inches from the top. Tamp to the collar with dry clay. A short piece of fuse is inserted in the touch-hole and in contact with the main powder charge. Open the flue door at the bottom of the stack, set the cannon on the bottom and in the center of the stack, light the fuse and close the flue door. The explosion shakes and loosens the soot adhering to the sides, causing it to fall to the bottom. It can then be removed through the flue opening.

An 8 x $1\frac{3}{4}$-in. cylinder of FFF powder is sufficient for a stack as high as 100 ft. and 4 ft. in diameter, or over. The number of shots necessary to clean a stack thoroughly depends on its condition. Ordinarily, three or four are sufficient, but if very dirty it may require more. The size of the charge and length of the cannon may be regulated to suit the height and diameter of the stack.

Some persons have a curious belief in the powers of engineers over the laws of nature. One representative citizen was heard to say to another, as they gazed from the deck of the little steamer that traversed Lake Tahoe at the 2000-ft. wall of the Sierras rimming Tahoe on the eastern side: "Wonderful work the engineers are doing; wonderful indeed! Their latest proposal is to construct a steel siphon over the mountains that you see over there and draw the water to the crest and run it down upon the plains of Nevada. There it will irrigate thousands of acres. It is quite simple, just as simple as a hose siphon. All that is necessary is to place an up-and-down pipe of sufficient size to carry the water." "Isn't it wonderful?" replied his companion —*Engineering and Mining Journal.*

Power-Plant Changes That Saved Coal

By B. S. REMLIEU

Instances are given in which losses were occurring in a steam plant, such as probably exist in many others. As a result of preventing these losses, the engineer was the means of saving about 700 tons of coal a year and incidentally was given a better plant to operate.

THE coal consumption previous to my taking charge of a certain power plant was around 3000 tons of pea coal per year. The first few days were spent in nosing about the building and supply closets. The initial discovery was a leak in the return-vacuum line of the heating system. When repaired, the result was an increase in the vacuum and a lowering in the back pressure on the engine.

Every time I went into the fireroom I found the registers in the fire-doors open, and each time I closed them. I turned around one day to find the fireman opening them after they had been shut. He said that the boiler manufacturer's representative had instructed him to keep the register open and that he ought to know. In order to make him see the point, I told him that when his wife wanted to cool off the kitchen stove she cracked the lids or opened the draft slide on the top of the fire. All air that goes into a furnace above the fire has to be heated and it takes coal to do it. To make sure that the registers would not be opened again, I bolted them shut.

A couple of days after that the fireman came into the engine room with his eyebrows and hair singed, the result of a "back draft" which he claimed was due to bolting the registers shut. His instructions were not to fire so heavy next time so that gas could not form without burning as fast as it was driven off. Fire light and often and there will be no danger of "flarebacks."

It was the habit of the fireman to keep the feed-pump priming valve open, which of course cooled the feed water somewhat. He claimed that the pump would lose its suction and become steambound with the valve closed. To prove that he was wrong, I disconnected the pipe and the next time the pump became steambound the fireman notified me. That gave me a chance to observe the action of the pump and locate the trouble.

The pump took water from an open heater and the suction pipe ran under the engine- and boiler-room floors for about 30 ft. and to the pump, which was elevated about 15 in. from the floor on a brick base. The water level in the heater stood about 18 in. above the pump-valve chamber. The trouble was cured by putting in a tee in place of an elbow on the suction line at the pump, and from the tee I ran a 2-in. pipe nearly to the ceiling of the boiler room and then to a point above a sink in a corner of the room.

As the back pressure carried was less than two pounds, the column of water in this vertical vapor pipe was rarely over four feet high and was free to move up and down in the pipe and keep the plungers supplied with water instead of vapor. It was never necessary to provide cold-water injection after that, and the valves on these lines were shut tight and the handwheels removed.

A difference in the coal consumption was soon noticed, and the superintendent woke up when the bill was less than $1000 for that month. I had to explain to the purchasing agent why we could not take all of a boatload of coal that he had ordered on a certain day and that he had figured there would be room for in our bins. As there was not room, the boat had to be sent to one of our other plants to finish unloading.

I had suspicions about a trap in the engine room, as it sounded as if steam was blowing through. One of the night engineers overhauled it and pronounced it all right, but the blowing could still be heard. Taking it apart myself, I found a hole through a partition wall that required a ¾-in. pipe plug to close. The night engineer said that he had seen the hole but thought it belonged there.

The practice in this plant was to clean boilers every six weeks, taking one boiler each Sunday. On coming in Sunday morning I found the handhole plates removed and in the water legs a little scale which was easily washed out with a hose. The manhole plate was still on, and the firemen said that it was removed only once a year. It was taken off, and on getting inside I found the scale very heavy on top of the tubes. It was labor wasted to remove it from the tubes with the tools I had, and I made a requisition for a tube cleaner, but it was turned down by the "man higher up," who said that the scale could be removed by scrapers and chains.

As the superintendent seemed to have a favorite compound, I decided to use it. The firemen had been in the habit of feeding a waterpailful of compound to each boiler once a week. I took the feeding job myself and filled the feeder with a gallon of the compound each morning. Soon the boilers began to prime.

"Too much compound," said the fireman.

"Blow down," said I. "Too much dirt."

I made them blow three times in 24 hours. The engineers had to see that they did this for their own protection in order to keep the cylinder heads from going out. When they got into the habit, we had no more trouble from priming. I tested the boiler water each day, drawing a sample from the gage-cocks and dipping a piece of litmus paper in it and kept the water alkaline enough to tint to a decided blue the paper we used to test for ammonia leaks.

One day the firemen asked me to look at the boilers. I did so and saw that a number of tubes were leaking. Within the week all the boilers were leaking. The tubes were re-expanded, but in a few days they were leaking again.

"Dirt," said the boilermaker.

"Couldn't be," said I. "The boilers were open only a few weeks ago and I could see between every tube, and the head was clean."

To convince myself, I opened up a boiler and, sure enough, the scale was packed up solidly against the head; I poked this down and got after the others. No more trouble from leaks, but the scale that we got out of those boilers broke records.

The hot-water tanks also bothered. They were heated with live steam, and large quantities of water were used for laundry and domestic purposes. On opening up the tanks, I found that the heating element consisted of a continuous coil containing about 75 ft. of 1½-in. brass pipe, and while discussing the situation with one of the other engineers, the suggestion was made that we could pull the exhaust steam through the coils with the heating-system vacuum pumps. Accordingly, a connection was made between one of these pumps and the coil outlet pipe from the hot-water tanks, exhaust steam being supplied to the inlet piping of the coils. To do this, we had to install a new 2-in. grease extractor and a 2-in. line across the boiler room to connect with a pump-exhaust line. This was a shorter run and a less expensive job than to tap into the main exhaust, and being of 2-in. pipe we could cut and thread it with the tools on the job. This pump maintained a vacuum of 12 to 15 in. easily at slow speed on this exhaust line. When we turned steam on this outfit it worked, and then we got a couple of traps to put on the return of each heater so that when one of them got heated up it would not interfere with the vacuum on the other.

The success with the hot-water tanks led to the application of exhaust steam on an absorption ice machine, which was designed for high pressure and usually operated at 75 lb.; but by experimenting, it was found that it would operate a large part of the time with 30 lb. if the ammonia charge was kept strong enough. Another grease extractor was bought and a back-pressure valve, and the exhaust steam of the ammonia and brine pumps was put through it, also the exhaust of a small house pump, the cylinder proportions of which were sufficient to permit it to work against that back pressure.

The reducing valve on this ice machine started to dance a chatter, and to stop that the diaphragm connection was changed to the outlet of the generator coil instead of the inlet, so the pump pulsations of the steam would be smoothed before they reached the diaphragm pipe. This idea also worked. The exhaust steam from these pumps was sufficient for this ice machine except during the hottest months of the year, when it was necessary to again switch over to live steam.

I had already ordered all the carbon lamps in the building out and supplanted them with tungsten of the same candlepower, thus making a considerable current saving and increasing the lighting effect. The superintendent was shocked when told that the carbon lamps were good only for scrap, but they were kept for use in the coal bins and for portables, etc., where a tungsten might not stand the hard usage.

Automobile chauffeurs were in the habit of plugging in on the charging board whenever they felt like it. A rule was made that charging could be done only at light-load hours, or from 9 p.m. to 8 a.m. and during the noon hour.

A new rule was also made that the tubes of the boilers must be cleaned twice a week and the ashes removed promptly from the ashpits after cleaning fires. The firemen rebelled at this and went in a body to the office, protesting that they were being overworked, etc. It was suggested that the order be taken down, but this was declined and it was proved that their work was easier, as they were burning several tons of coal less per 24 hours than they had been. The sign is up yet and the tubes are being blown twice a week.

Then, to prove that they were being overworked, the firemen let the steam go down while blowing tubes. A recording gage was set up in the boiler room and the first week each fireman broke it—accidentally. The gage was then placed in the superintendent's office above the engine room, and a slot was cut in the valve disk leading to it so that it could not be shut off. Next, the file of steam charts was stolen, making it necessary to adopt the practice of taking it home each night.

The elevator pumps came in for attention at nights and Sundays. When they should have stopped, owing to the elevators being out of service, they continued to keep going, and it was found that an obscure sidewalk lift with the valve cups in such condition that water was passing the valve all the time was responsible for this. New valve cups shut the pump down.

When winter came on, I found we were short of exhaust steam for heating the building, although there had always been an excess in former winters, so it was necessary to save exhaust steam. Heating surfaces not needed were covered and pipe covering shifted around to cover those surfaces where it was needed most. For instance, covering was not needed on the vacuum return lines, as any heat above a certain temperature saved would have to be killed by injection water at the pump, while heat saved on the steam risers would give more for use in the radiators where it was needed.

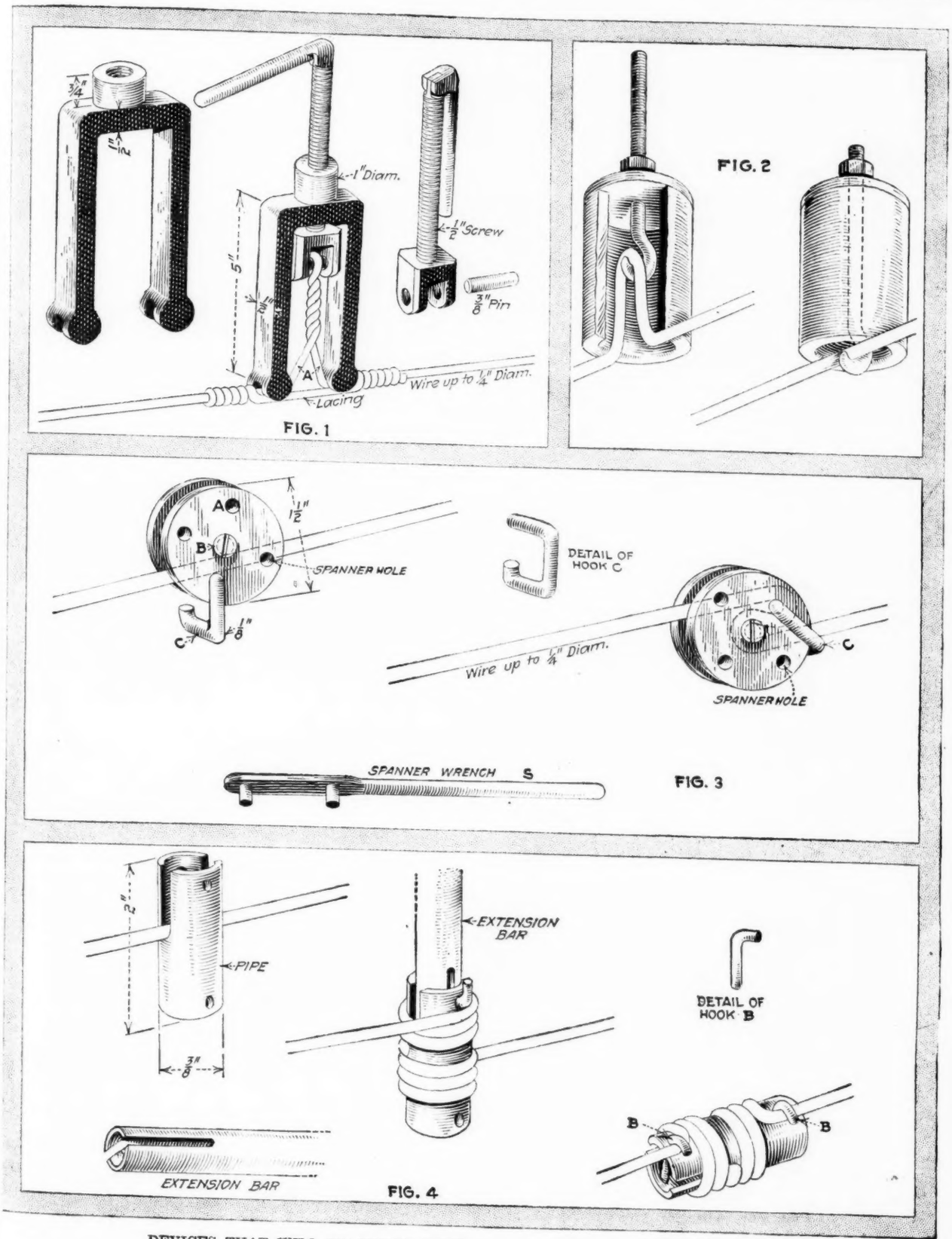
The grease extractor discharged to the sewer without a trap. It was connected to the overflow trap of the feed-water heater and that much was saved, besides the cost of a separate trap. The main engines were also indicated and the valves refitted, but before I got a chance to get in much more of my saving in that plant, I was sent to one of the company's larger plants, where I am continuing my "experiments." About 700 tons of pea coal was saved per year in the plant as a result of the changes mentioned. The engineers entered heartily into the work, and one of them is now in charge. The firemen, however, and their allies, the coal passers, were interested onlookers only and never once offered a suggestion or gave a hand. Every move made was construed by them as something that was going to be put over on them, and they are all still there firing coal and wheeling ashes, which they probably will do to the end of their lives.

Four Wire Take-Up Devices

By M. P. Bertrande

The illustrations show four forms of wire tighteners for use in and about the power station. Fig. 1 is somewhat elaborate and is used to take up the slack of a line of wire and hold it while the jumper, or "lacing," is wrapped on as shown and soldered, after which the wire is cut at *A* and the ends are bent back over the splice. Fig. 2 operates on the same principle, but is more easily made, as will be seen. Fig. 3 is made of two washers held together by a bolt *B* through their centers. The device is placed on the wire as shown and turned by means of the spanner wrench *S*. It is locked in position with hook *C*. It is left in place, avoiding the necessity of a splice. Fig. 4 is a short piece of pipe

used as a center around which the wire is wound. Hooks *B* are then put in as shown, and the spool is allowed to turn parallel to the wire. The extension bar is used to hold the spool at right angles to the wire while winding up and also to put a pipe wrench on to do the winding with; or a small bar through a hole in this bar may be used. If used outdoors, any of the devices left on the line should be taped over to prevent rusting, and in any case if current is carried by the line the tightener should be taped as a safety measure.



DEVICES THAT WILL BE FOUND USEFUL FOR TAKING UP SLACK IN WIRES

Ontario Boiler

D. M. MEDCALF, CHIEF INSPECTOR OF BOILERS FOR PROVINCE OF ONTARIO IN HIS OFFICE NEAR PARLIAMENT BUILDINGS

THE editor enjoyed the privilege recently of passing a day with D. M. Medcalf, Chief Inspector of Boilers for the Province of Ontario. Under existing regulations, it is the function of the Boiler Inspection Department to pass upon new installations only, or installations in which changes or repairs are made. The further supervision of the plant passes to the Factory Inspection Department. This leaves a large number of boilers

The boiler in a cheese factory, a fragment of which is shown in Fig. 1, exploded, killing the owner and demolishing the building. The boiler was more than fifty years old, 36 in. in diameter, and although only 10 ft. long, was made in four courses, the second course being

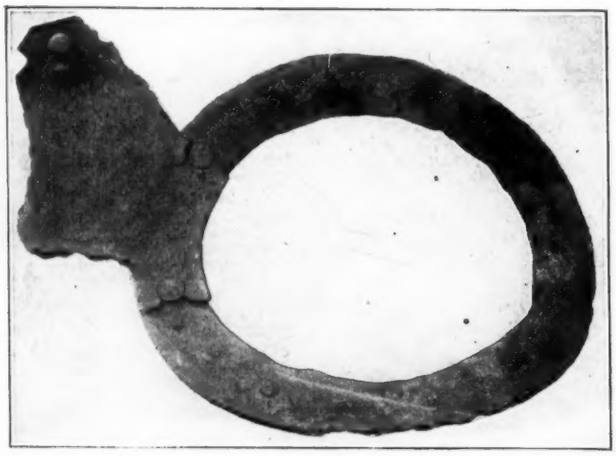


FIG. 1. WEAK REINFORCING RING WITH ONLY EIGHT RIVETS

built up of five pieces, some of which were patches. The manhole opening was cut with its long axis running longitudinally with the shell of the boiler, and insufficiently reinforced by a 3 x ½-in. ring secured to the shell by eight ⅝-in. rivets. Six of these rivets had been broken off previous to the final failure, permitting steam to

FIG. 2. EXCESSIVE ROLLING CUT TUBE END NEARLY OFF

FIG. 3. CLAMP INTENDED FOR CRACK IN FIRE SHEET

escape through the rivet holes beneath the reinforcing ring, corroding the plate and ring, the plate being wasted almost entirely away in places. The condition of the boiler must have been known, even if its seriousness was not appreciated, for a special packing ring had been used in trying to prevent leakage at the manhole.

The advice of the department was sought in the case of a boiler that leaked badly around the 4-in. tubes. An attempt to roll the tubes revealed the fact that this

FIG. 4. TUBE CORRUGATED BY UPSETTING OR CLEANER

had been already overdone (Fig. 2). A new boiler had been ruined by over-strenuous work with the expander.

Fig. 3 shows a clamp that an "ingenious" engineer

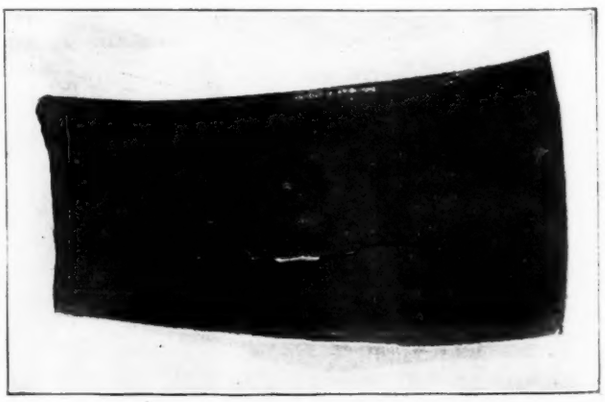


FIG. 5. PLATE CRACKED IN FLANGING TOO COLD

put over a crack in a firebox. Roofing paper was used for packing. Needless to say the patch lasted about as long as it took to write this paragraph about it.

Inspection Office

which were installed before the establishment of the Boiler Inspection Department, which have not been passed upon, but reinstallations, that is, second-hand boilers, sold or exchanged, alterations and repairs must be approved by the Chief Boiler Inspector. The supervision of the boiler inspector extends also to piping and connected accessories, digesters and other pressure vessels, and is about to be extended to economizers.

RESIDENCE CONVERTED INTO OFFICES FOR TRADE AND LABOR BRANCHES, INCLUDING BOILER AND FACTORY INSPECTION

A two-course horizontal return-tubular boiler developed a bag on the front sheet extending halfway around the circumference and for nearly the full length of the course. This distortion of the sheet pulled the bottom of the front head inward, buckling the through stays and the tubes upward. When the tubes were cut out 14 of them (7 in the bottom row) were found to be corrugated as shown in Fig. 4. It was at first supposed and is still maintained by some that the corrugations were due to the endwise pressure on the tubes, but others are inclined to the belief that they were caused by the improper use of a mechanical tube cleaner. This view is supported by the tool marks and the sharp edges of the depressions viewed from the inside.

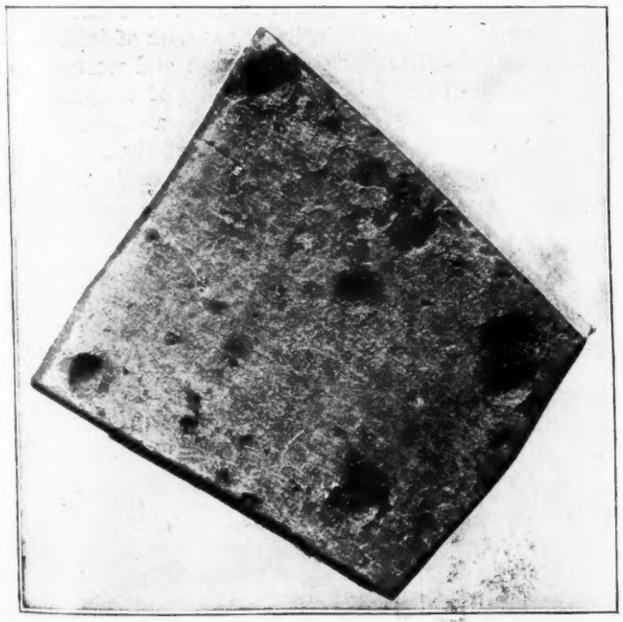


FIG. 6. A PRONOUNCED CASE OF LOCALIZED PITTING

Fig. 5 shows a half-inch plate broken through in flanging, owing to working the metal at a "blue heat."

Fig. 6 shows a case of pitting that occurred near the blowoff pipe in a horizontal return-tubular boiler. The ⅜-in. plate is eaten nearly through in spots, but, curiously, these were the only places where such action occurred. The piece shown was replaced by a patch.

The owner of the vertical boiler from which the head shown in Fig. 7 was taken was very much aggrieved because he was not allowed to "half-sole and heel" it still further. It is cracked in more than twenty places between the tube holes, and attempts had been made to mend these in places by tapping and plugging and in others by autogenous welding.

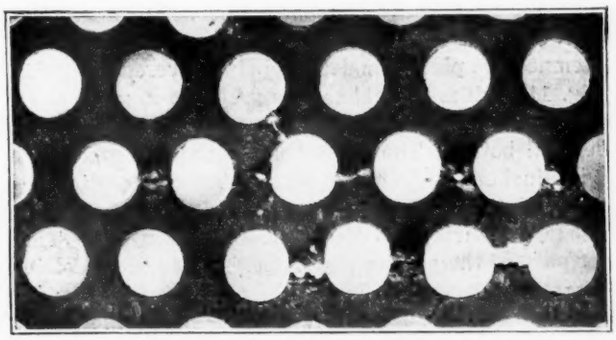


FIG. 7. SHEET WAS BAD AND ITS TREATMENT WORSE

Fig. 8 shows a typical case of lamination in the side sheet of a locomotive boiler. The first indication was an elongated blister. When this was cut out, the true condition of the plate was revealed.

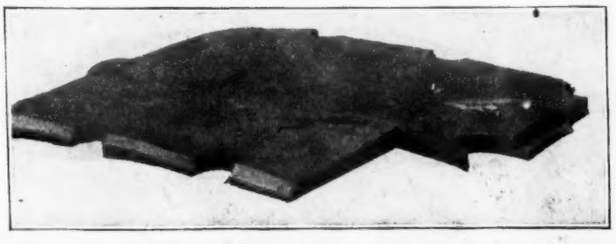


FIG. 8. BLISTER DISCLOSED CONDITION OF PLATE

Fig. 9 shows a "blister," taken from the bottom of a horizontal return-tubular boiler that became overheated and bulged. The trouble was caused by a deposit of scale and is not an uncommon defect in externally fired boilers, when not kept clean. This case is interesting because of the fact that the bulged patch

FIG. 9. A SECOND BLISTER FROM ONE SPOT

FIG. 10. PLATE FROM BOILER JUST OUT OF SERVICE

shown was put on to replace a bulge cut out of the original shell of the boiler. One warning did not appear to be enough for this boiler owner.

Fig. 10 shows a portion of a plate taken from a firebox boiler, that was pitted through in dozens of places. It was so badly corroded that a penknife could be pushed through it in almost any spot. The boiler had been carrying 75 lb. of steam up to the time the department condemned the plate, the defects being covered by scale.

Fig. 11 verifies the old saying "A little knowledge is a dangerous thing." The section of plate was cut from a vertical boiler. The rivet holes shown are of a lap longitudinal seam. A crack had developed close to the rivets, and it was decided by someone that the proper method of repairing the defect was by "sewing" it. The lower part of the picture shows the outside of the plate with the crack welded over. The welding was done after the "sewing" and is a surface weld of the poorest variety. An intelligent engineer would never have attempted to make this repair in the manner shown, and it is a surprising thing that the boiler did not explode. The job held tight until about 50 lb. pressure was raised and then started to leak badly.

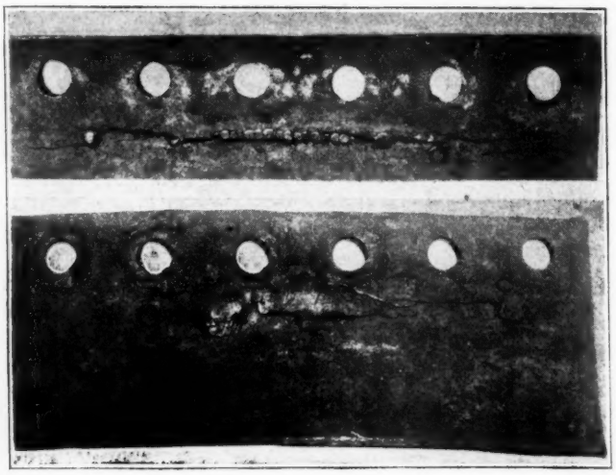


FIG. 11. "HEROIC" ATTEMPT AT REPAIRING A CRACK

Figs. 12 and 13 show a welded tank (36 x 56 in.) which was used to contain anhydrous ammonia and exploded, resulting in the death of three men and the almost complete destruction of the building. No safety devices were attached to the vessel and a gage-glass, to show the height of liquid, had been broken some time previous to the accident, and had not been replaced. As the new tank will come under the supervision of the Boiler Inspection Department, one that is suitable for the service with a fair margin of safety will be installed.

Mr. Medcalf's office is a veritable museum of interesting exhibits of boiler defects in design and workmanship. It is often urged by the opponents of compulsory boiler inspection that ordinary caution and care for their own lives and property and those of their associates are enough to impel boiler users to avoid taking chances with inadequate and dangerous apparatus. It might be, if they realized the chances which they were taking or were competent to pass upon the fitness of the given appliance. The length to which some people will go through carelessness, ignorance or foolhardiness is shown in many ways.

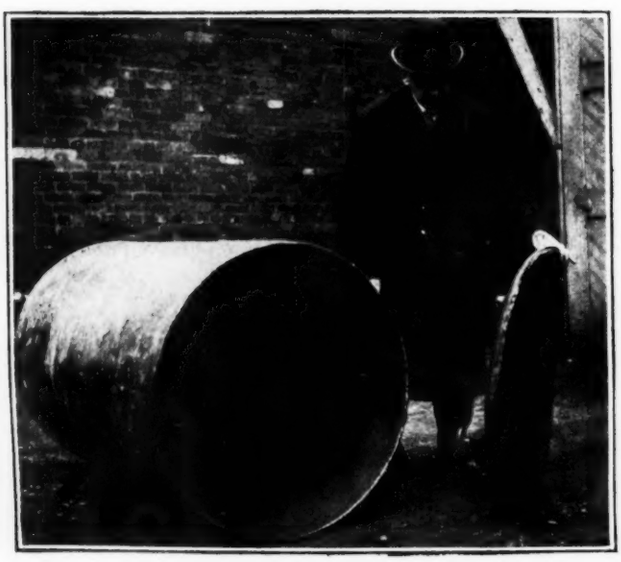


FIG. 12. WELDED HEAD OUT OF AMMONIA TANK

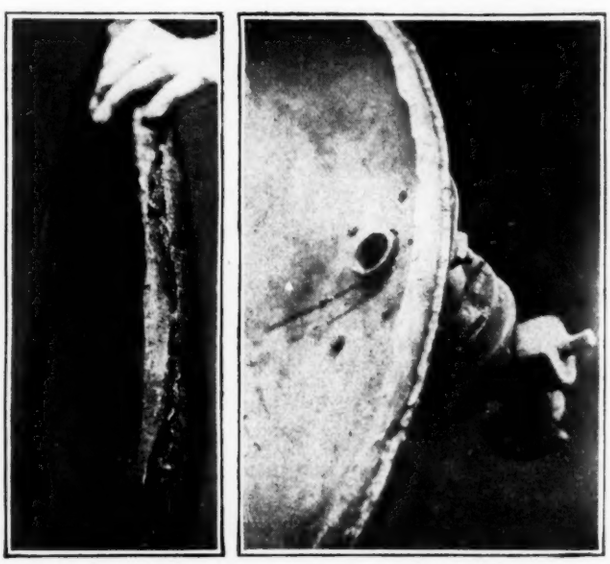


FIG. 13. VIEW SHOWING POOR QUALITY OF WELD

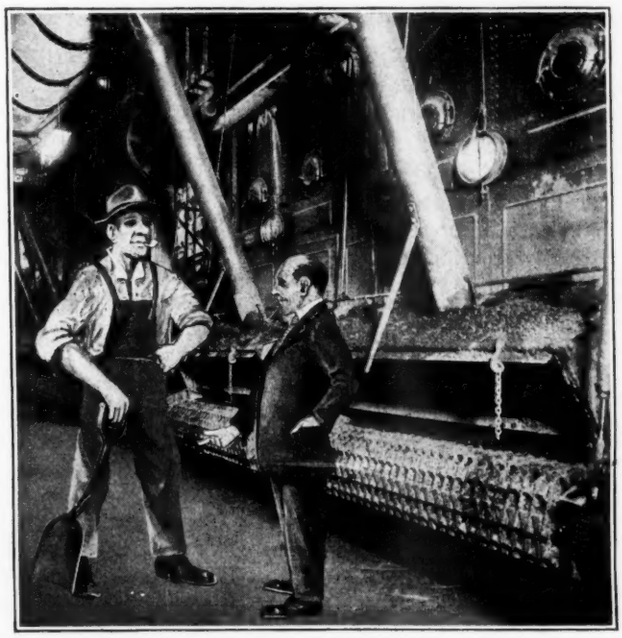
Liability in Case of Boiler Explosions

By BILL B. BANGER

Bill comments on several court decisions relating to boiler explosions wherein the facts as stated do not warrant the verdict, according to his reasoning.

IT'S a dinged long time since I meandered into print, because of promiscuous reasons, etc., and I don't know but that it would be just as well for all concerned if I had writer's cramp right here and now, or words to that effect. What I want to spout about is law, not because I know anything about it, but because one opinion in this old U. S. A. is said to be just as good as another. Now I've got some befuddled opinions of my own and some of 'um backed up by facts, which is more than some law has got that I might mention.

The pint before the jury is law and engineerin' common sense. This oration has been promulgated or somethin' of that sort, by an article that was published on page 648 of the Oct. 29 issue of *Power* by C. T. Sherlock regardin' liability in case of biler explosions. Some of my old friends will remember that I went through one hair-raisin' biler explosion, and so I'm in a position to know what I'm talkin' about. As I said to the fireman, I don't hesitate a mite to say that a bunch of bilers have exploded without any dinged blame bein' attached to either the owner or the engineers, because the cases were of such nature that the Old Nick himself wouldn't have known that trouble was hatchin.' Be that as it may Sherlock—nothin' is said about his pal, Watson—tells about a biler what had three water gages and a gage-glass, the latter bein' broken, by the way, and of the biler bein' blown to kingdom come or some other place while a mechanic was puttin' in a new glass for the fireman.



I TOLD THE FIREMAN THAT A BUNCH OF BILERS HAD BUSTED WHEN IT WASN'T THE FAULT OF ANYBODY

After the fireman was planted, the relatives got the idee that his feelin's had been damaged to some extent, more or less, and they got busy and sued his employer for damages or cold cash, which is the same thing.

Well, to make a short story long, the jury gave a verdict of $2000 to the fellow who cashed in when the biler busted, statin' that the explosion was caused by the defective water glass.

Now, if I had been allowed to investigate the case, I would have questioned the owner of the plant to find out what kind of a man he had put in charge of the biler that wanted to meander all over the state. We don't have much evidence as to his mental or mechanical fitness, but if he had to depend on another feller, sent by the foreman of the shebang, to put in a new water glass, it looks mighty certain that this fireman didn't have any more mechanical ingenuity than a Hun boche after a Yankee soldier has got through practicin' on him with a bayonet.

Any engineer knows that a water glass is just a careless man's guide. It's merely a fixture on a biler for his convenience, and it ain't expected that a fellow who throws in the coal is goin' to depend on it altogether, but it is expected that in the course of human events he will use the try-cocks frequently and he will do it if he has the glimmerin' sense of a club-footed ash handler. If the aforesaid fireman didn't ascertain the true water level by means of the try-cocks, especially when the water glass was broken, it stands to reason that he didn't know where the water level was and nothin' else could be expected. The defendant contended that the fireman was guilty of neglect because he didn't test his try-cocks and find out just how much water there was in the kettle. Throwin' all prejudice aside, it looks as if the owner, if his contentions were correct, knew more about the biler than did the man he hired to run it. This question of low water bein' the cause of biler explosions has been disproved so many times that I refuse to pass the joke on to the next feller. The most recent test for the purpose of explodin' a biler by low water was back in 1912 (*Power*, page 31, June 2). This was the case of a locomotive type, and when the water got 14½ in. below the crown-sheet, and 23 minutes after the sheet was bare, it pulled away from the stay-bolts, after the sheet had become highly heated.

With a return-tubular biler the water has got to be mighty nigh all out before the plate will burn, and the chances are that it would take more than one case of low water to burn the metal enough for it to fail. If the explosion under discussion was the result of low water, it was because the water had been low several times before and everybody ought to be tickled to death that the explosion held off until the water was low rather than to have hung on until there was plenty in the biler, because the excitement would have been multiplied several times, as when a biler explodes containin' a bunch of water it always musses things up worse, so to speak, than when the water is low.

Taking everythin' into consideration, I hazard a 2 to 1 guess that the biler blew up because it wasn't strong enough to take care of the ordinary pressure and that

the broken gage-glass had nothing directly to do with it, and that the fireman was an innocent victim from operatin' a biler that should have been on the junk pile.

It is assumed that the biler mentioned in the foregoin' was not under state, city or insurance inspection, but it don't look as though that would have made much difference with the final verdict of the case if Sherlock's next recitation is a criterion, whatever that is.

Watson's pal tells in the same article of how another biler blew up with a workin' pressure of 75 lb. and a city inspection certificate hangin' on the wall. Of course the certificate didn't have anythin' to do with causin' the explosion; neither did it prevent it, and some might want to know what good it was anyway. All I can say is damfino.

The owner of the biler was charged with not havin' used reasonable care to provide the plaintiff, in other words that's the feller who was the fireman, with a reasonably safe place in which to loaf and that the owner had failed to inspect the biler although he knew that it was defective and that the engineer did not know of these defects and did not have an equal means of knowin' of um.

The verdict was $10,000. The defendant, that's the owner of the shebang, appealed the case, claimin' that it was the business of the engineer to inspect the biler, and that he was guilty of negligence in failin' to make suitable inspection. The Court told the owner that he wasn't onto his job and that the inspection rested with the owner, and that the fireman had a right to assume that, as there was an official inspection certificate on the wall, due care had been exercised by the owner.

From an engineerin' pint of view, it is difficult to see wherein the owner was guilty of negligence, as the biler had been inspected and the certificate said so. On the other hand, it must have been a mighty strange proposition if the owner had more knowledge of the condition of the boiler than did the engineer. Most of us "knights of the engine room," as Socrates said or perhaps it was Pluto, generally have all the chance to find out in what condition a biler is in, and a wise feller will squint over one both inside and out in a rather thorough manner before he has been in charge many days. If an engineer don't have a chance to find out what shape his biler is in, who in the name of Tophet does?

Coming to my thirdly, we will take up the case of the biler that exploded after 40 years of service, probably off and on. Being a sawmill biler is enough to condemn it without any more evidence. However, the biler exploded after 40 years, a ripe old age, as a barnstormin' actor would say at a hen-fruit reception. But it required several courts to arrive at the verdict that the explosion was caused by some rusty rivets because one was so found.

Well, a biler used in a sawmill might reasonably be expected to have at least one rusty rivet and a few buttons on the bottom sheet over the fire for good measure. The court stated that a rusty rivet could not withstand a pressure that a good rivet would. This makes me think of some of the articles that the war expert sometimes publishes, to the effect that if the enemy retires they are bound to give ground and if the Allies advance they will go forward. To be sure! To be sure!

One court found for the plaintiff, and the court that finally juggled the case reversed the previous decisions and decided the case in favor of the defendant. Now a jury of engineers would never have come to the decision that a man or company who operated a biler 40 years was not responsible for the life of a man who was hired to operate it. I know a few engineers, by heck, but I don't know one who would so far forget the first principles of "safety first" as to even hesitate about refusin' to operate a biler of such ancient birth, or to have the owner arrested as a menace to the safety of the community.

Naturally, we must respect the dignity of the Court, but when it comes to decidin' engineerin' questions something besides strict law should govern both the lawyers, judge and all others concerned. I don't know as these verdicts make much difference to the fellers who had flowers placed on their coffins, but such cases don't aim to prevent ignorant men from operatin' bilers, when the law don't prevent them, or to restrain owners from hirin' men to run bilers that are hardly strong enough to hold water as a horse waterin' trough.

Chart for Finding Factor of Evaporation

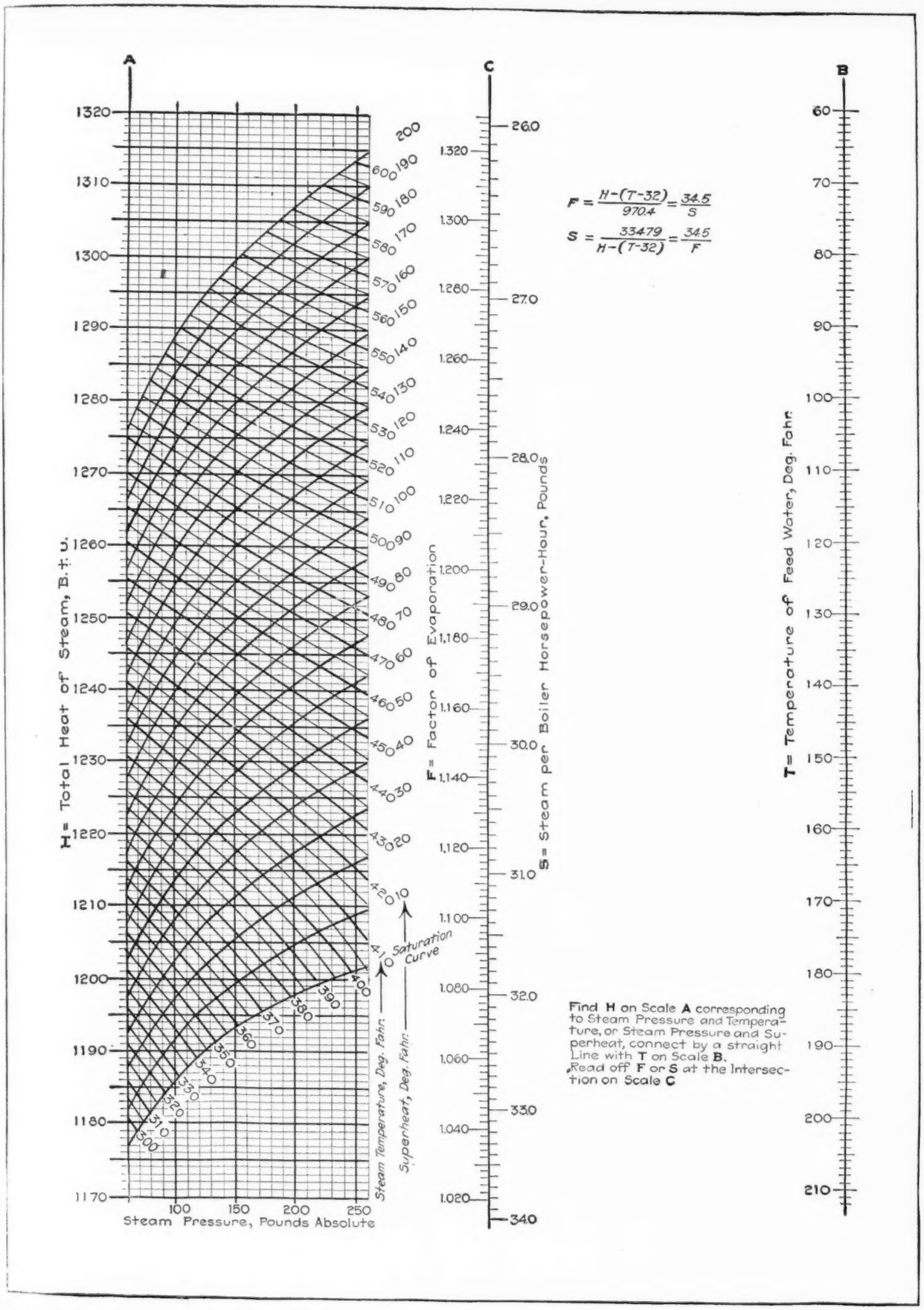
BY FRANZ SZABO

When making boiler-performance calculations the accompanying chart is useful for finding the factor of evaporation or the number of pounds of steam generated per boiler horsepower per hour without the use of steam tables, when the steam pressure, the steam temperature or the degree of superheat, and the feed-water temperature are known.

Scale A shows the total heat H in B.t.u. per pound of steam. Curves of constant temperature and constant superheat from the saturation point to 200 deg. F. of superheat have been constructed on the right of scale A for steam pressures varying from 60 lb. to 260 lb. absolute. Those pointing toward the upper right-hand corner are curves of constant superheat; those pointing toward the lower right-hand corner are curves of constant temperature. Scale B shows the feed-water temperatures varying from 60 to 212 deg. F. The results are found on scale C, giving the factor of evaporation F on the left side, and on the right side the number of pounds of steam S generated per boiler horsepower per hour.

An example will illustrate the use of the chart: Assume a steam pressure of 150 lb. absolute, a steam temperature of 460 deg. F., and a feed-water temperature of 200 deg. F. Locate the point of intersection of the vertical line corresponding to 150 lb. steam pressure and the curve corresponding to 460 deg. steam temperature, move from this point in a horizontal direction to scale A and find that the total heat per pound of steam is 1250.5 B.t.u. Connecting 1250.5 on scale A with 200 deg. F., the feed-water temperature, on scale B by a straight line, the result on scale C will be a factor of evaporation of 1.115 on the left side, or on the right side 30.95 lb. of steam generated per boiler horsepower per hour.

When the degree of superheat is known, use the curves of constant superheat instead of the curves of constant temperature. For saturated steam use the saturation curve, which is zero superheat.


A
B
C
H= Total Heat of Steam, B.t.u.
Steam Pressure, Pounds Absolute
Steam Temperature, Deg. Fahr.
Superheat, Deg. Fahr.
Saturation Curve
F= Factor of Evaporation
S= Steam per Boiler Horsepower-Hour, Pounds
T= Temperature of Feed Water, Deg. Fahr.
$F = \frac{H-(T-32)}{970.4} = \frac{34.5}{S}$
$S = \frac{33479}{H-(T-32)} = \frac{34.5}{F}$
Find H on Scale A corresponding to Steam Pressure and Temperature, or Steam Pressure and Superheat, connect by a straight Line with T on Scale B. Read off F or S at the Intersection on Scale C

ALIGNMENT CHART FOR FINDING FACTOR OF EVAPORATION CORRESPONDING TO GIVEN STEAM CONDITIONS AND FEED-WATER TEMPERATURE

Visits of Inspector Brown—XXXV

BY J. E. TERMAN

The Chief tells Brown how Casey can get the most strength out of a quadruple-riveted joint in a high-pressure tank, using 1⅛-in. rivets.

AS BROWN came into the Chief's office, his expression clearly indicated that some unsolved problem was worrying him.

"Well, Brown, what is the trouble today?" asked the Chief.

"Casey has put up a question to me, Chief, that I don't know how to answer, and if I don't give him an answer tomorrow, my stock at Casey's shop will drop several points. Casey, and even his foreman, have been extremely nice to me for a long time now, and I hate to have things change. You know, Chief, Casey's riveting outfit can't drive a very large rivet, and he has some high-pressure tanks to build that will need plate about an inch thick. He asked me to show him how he could get the most out of a quadruple-riveted joint using 1⅛-in. rivets. I promised him I would have the problem worked out when I came back to inspect a boiler tomorrow. I must go there to make the inspection, Chief, but I surely do hate to have Casey tell me all the things that I know he will have to say about me, and boiler inspectors in general, if I fail to give him the promised answer to his question."

"I will be glad to try to help you out, Brown," said the Chief, "but first I want to state that there is not necessarily a direct and conclusive answer to Casey's question. If the combination of rivet sizes and plate thicknesses is such that an arrangement that will give a true joint of maximum efficiency is not a practical one, then the answer is not necessarily a positive one. There are two very practical considerations that must be decided before an attempt is made to design the best joint for a given case. First, what is the limit to the size of rivets that may be driven in the shop that will do the work? Second, how far apart may the rivets be spaced along the calking edge, and still permit proper calking of the joint? The riveting equipment in the average boiler shop cannot handle rivets of sufficient size to get the best results for strength. This is particularly so in the case of thick plates, and in such cases the best that can be done is to select the largest rivet that may be properly driven and make the best joint possible out of that. This is the case in Casey's case, if you will pardon the jingle in that expression," said the Chief.

"Casey knows that he cannot drive a larger rivet than 1⅛ in. properly, and that is the reason he has specified that size. Of course the rivet holes would have to be about $\frac{1}{16}$ in. larger than the rivets, therefore the size of the holes we would figure on in this joint would be $1\frac{3}{16}$ in. in diameter, which of course would also be the driven size of the rivets.

"Now, Brown, I will not for a minute try to tell Casey just how far apart along the calking edge he can space these rivets and still be able to make the joint tight. This matter of the maximum spacing of rivets along the calking edge is a free field for anyone's guess. If we should tell Casey that any particular amount was correct and the joint could not be made tight when the vessel was completed, Casey would, without doubt, claim that the design was improper, no matter how poor the workmanship might be. If we have to use a pitch of rivets that we consider to be the maximum possible, in the design of this joint, be sure to tell Casey that you only suggest this spacing. If he wants to change it, you can redesign the joint to give him the most strength with his own idea of rivet spacing along the calking edge."

"Well, Chief, how are you going to get at the spacing you will recommend?" asked Brown.

"It would be too long a story to tell, Brown," answered the Chief, "but mainly by guesswork and experience. If the joint in this 1-in. plate is to be made to the requirements of the A. S. M. E. Code, the strap thickness will have to be at least ¾ in. Suppose we take ¾ in. as the thickness of the straps. My guess would be that rivets driven in $1\frac{3}{16}$-in. holes along the edge of a ¾-in. strap could be spaced $5\frac{3}{4}$ in. apart and have the calking properly done.

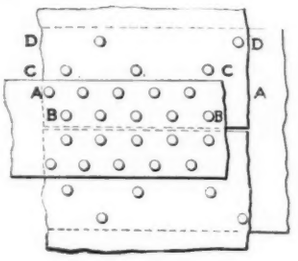


FIG. 1

"To start to design this joint intelligently, we must first know the relation between the shearing, crushing and tensile strengths, with the size of rivets and plate thickness to be used. We will use Code values, 44,000 and 88,000 lb. per sq.in. in single and double shear respectively, and 55,000 lb. per sq.in. for the tensile strength of the plate. The resistance of a rivet to single shear would be $0.7854 \times (1\frac{3}{16})^2 \times 44{,}000 = 48{,}732$ lb., and for double shear twice this amount, or 97,464 lb. Since the reduction of plate section by drilling a rivet hole through the plate is $1\frac{3}{16} \times 1 = 1.1875$ sq.in., the strength removed would be $1.1875 \times 55{,}000 = 65{,}312$ lb. You will see presently how I intend to use this value, Brown.

"Assuming 95,000 lb. per sq.in. for the crushing strength of the plate, as is done in the Code, since the plate is one inch thick, the resistance at each rivet by this mode of failure would be $1 \times 1\frac{3}{16} \times 95{,}000 = 112{,}812$ lb. It is easy to see that since this value for crushing is even more than the shearing strength of a rivet in double shear—97,464 lb.—crushing will not be a factor to be considered in estimating the strength of the joint we are to design. Therefore we may dismiss any further notice of it.

"As I understand the problem," continued the Chief, "Casey wants to use a joint of this type," sketching Fig. 1.

"Our first consideration is to see that the spacing of rivets along the line *AA* is not in excess of the maximum amount we have agreed on, $5\frac{3}{4}$ in. Of course, we have yet to determine if this amount of pitch is really necessary, before adopting it. We will assume

that the spacing of the rivets in both the inside rows *AA* and *BB* is to be the same.

"Since we are to be concerned only with the shearing strength of the rivets and the tensile strength of the plate, in the joint under consideration, in order to have it of the best design for strength, the spacing of the rivets along the calking edge should be such that the shearing strength of two rivets just equals the tensile strength of the plate between two adjacent rivet holes. As we have already found, the shearing strength of a $1\frac{3}{16}$-in. rivet in double shear is 97,464 lb., therefore two such rivets would have a shearing strength of 194,928 pounds.

"If we let y represent the length of plate one inch thick that would be of equal strength to two rivets in double shear, the following equation would express the value of y:

$$1 \times 55{,}000 \times y = 194{,}928$$

that is, y would be $\frac{194{,}928}{1 \times 55{,}000} = 3.544$ in. This value of y is, of course, the length of the net section of the plate between the rivet holes. The pitch of rivets would be greater than this amount by the diameter of a rivet hole; that is, the pitch would be $3.544 + 1\frac{3}{16} = 4.73$ in. You will see at once, Brown, that this is more than an inch less than the 5¾-in. pitch which I at first assumed as a maximum to be used. I have no doubt that Casey will agree that he can calk a joint of that design tight.

"We have now considered the design of the double-shear part of this joint and may proceed with the proper location of the single-shear rivets in the outer rows."

"Why, that is already done, Chief. The rivets in row *CC*," indicating Fig. 1, "are always twice the pitch of those in row *AA*, and those in row *DD* are four times the same amount," said Brown.

"Well, I will admit that such spacing is the usual practice, Brown, but if you want to give Casey the benefit of the best spacing for strength in this joint, we will have to depart from the general rule. As you can see, the rivets in the outer rows in a joint of this type cannot seriously affect the tightness along the calking edge. If greater strength could be obtained by spacing these rivets either closer together or wider apart in the outer rows, such change from the usual design should be made. If the spacing of rivets in the outer rows is closer together than the even multiple of 2, as commonly used, the result will generally be a distinct advantage. This will be particularly true in the case of heavy plates; that is, plates that are relatively thick for the size of rivets used, as in the present case. You can see that this is so, for the closer spacing of the rivets will bring the parts together more firmly.

"Now I want to return to that calculation I made a short time ago, which showed that the strength of the plate that would be removed by drilling a $1\frac{3}{16}$-in. hole was 65,312 lb. This calculation gives us a direct clue to the spacing that should be adopted for the rivets in the outer rows. If the rivets added in the row *CC*, Fig. 1, are to be of maximum value in increasing the joint strength, the following conditions must be met: The net section strength per pitch of rivets in row *CC* must exceed the strength of the net sections over the same length in row *AA* by an amount equal to the shearing strength of one rivet in single shear.

"If the plate thickness was such that the strength of the metal removed by the drilling of a rivet hole was just equal to the shearing strength of a rivet, then spacing the rivets in row *CC* just twice as far apart as the rivets in row *AA* would give the desired result. You can easily see that this would be the case, Brown, by arranging the rivets in the two rows in this manner," said the Chief, drawing Fig. 2. "It is perfectly evident that the sections of plate between rivet holes *EE* contain just one rivet-hole diameter more metal than the sections of plate between the rivet holes *FF*. In the case we have under consideration, however, this equality between the tensile strengths and the shearing strengths does not exist, therefore some other spacing will be required to obtain the desired result.

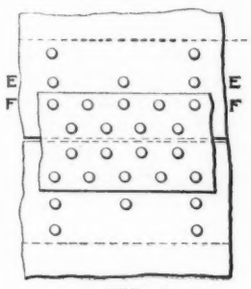


FIG. 2

"Since the spacing I have just shown you (Fig. 2) if used in this joint (Fig. 1) would increase the tensile strength of the plate between the rivet holes in row *CC* by 65,312 lb. per pitch, and the shearing strength is increased per pitch by 48,732 lb.—the shearing strength of one rivet in single shear—the pitch in row *CC* must be $1 + \frac{48{,}732}{65{,}312}$ times the pitch of row *AA* to meet the requirements we have specified; that is, equality between the tensile strength and shearing strength added to the joint by the placing of the rivets in row *CC*.

"Performing the division indicated by the above fraction and adding the result to unity, we would have 1.75, that is, the proper ratio between the spacing of the rivets in row *CC* with respect to those in row *AA*. Since we have already found that the pitch in row *AA* should be 4.73 in., the pitch in row *CC* would be 4.73×1.75, or 8.28 in. By the same process of reasoning it will be evident that the rivets in row *DD* (Fig. 1) should be pitched 1.75 times as far apart as those in row *CC*; that is, the outer pitch would be, $1.75 \times 8.28 = 14.49$ inches.

"The efficiency of this joint would be represented by the ratio between the net section length in the outer row and the pitch length in that row; that is, by the fraction, $\frac{14.49 - 1\frac{3}{16}}{14.49}$ As you will see by performing the operations indicated, the efficiency would be 91.8 per cent."

"How much was gained by shortening up the pitch in the outer rows, Chief?" asked Brown.

"Why, you can easily figure that for yourself, Brown. If by shortening the outer pitches, the strength at each row has been made such that the shearing of the rivets or the breaking of the net section of the plate were equally probable, by lengthening out the pitch, the rivets would of course shear. Therefore, if the pitch of the outer row *CC* (Fig. 1) had been made just twice the pitch along *AA*, and the pitch along *DD* just twice that along *CC*, the method of failure determining the efficiency of such a joint would be the shearing of all the rivets. You will remember that in adopting the

pitch of 4.73 in. for the rivets in the inner rows, we had in mind the making of the strength of the net section of the plate and the shearing strength of the rivets equal in value; therefore it is perfectly correct to take either one of the values, as far as the inner rows of rivets are concerned, since values are both the same, in figuring the efficiency of the joint.

"The outer pitch of a quadruple-riveted joint of the usual type, where the inner pitch is 4.73 in., would be, 4×4.73, or 18.92 in. The strength of the solid plate one inch thick, over a section 18.92 in. in length would be $18.92 \times 1 \times 55{,}000 = 1{,}040{,}600$ lb. The shearing strength of three rivets in single shear added to the shearing strength of eight rivets in double shear, would be 925,908 lb.; therefore the efficiency of such a joint would be $\frac{925{,}908}{1{,}040{,}600}$, or 88.98 per cent. Subtracting this from the value, 91.8 per cent., which we have just found, it is evident that by the closer arrangement of the rivets in the outer rows the efficiency has been increased 2.82, as well as securing a more compact joint."

"Gee! Chief, I know that is sure to make a hit with Casey; I guess I don't have to bother much about my visit to his shop tomorrow."

"What is the diameter of the high-pressure tanks that Casey is to build?" asked the Chief.

"They are 48 in., Chief, and they must be good for 450 lb. pressure at a factor of safety of 5."

"Well, we had best see if this design of joint for one-inch plate will suit Casey. The safe working pressure at a factor of safety of 5, and with the joint we have designed, would be represented by the fraction, $\frac{1 \times 55{,}000 \times 0.918}{5 \times 24}$, and it would therefore be 420.7 lb., which seems to be about 30 lb. shy of Casey's requirements," said the Chief. "We had best complete the solution of the problem before you go to the shop if you want to make a real hit with Casey.

"It is easy to see that if the joint efficiency should remain the same, the increase in plate thickness required would be $\frac{30}{420}$, or 0.0714 in. Of course you can see that the joint efficiency is bound to fall off some as the plate thickness increases, so that the necessary increase in the plate thickness will be something more than the amount just found. The nearest commercial size would be $1\frac{3}{32}$-in. plate. Suppose we try that?

"Proceeding to design a joint of the greatest strength, of the type considered, using $1\frac{3}{16}$-in. rivet holes, we find that the length of the net section of the plate between the rivet holes on the inner rows would be $\frac{194{,}928}{1.09375 \times 55{,}000}$, or 3.24 in. The pitch of the rivets on these inner rows would therefore be $1\frac{3}{16} + 3.24$, or 4.4275 in. Similarly, the ratio between the inner pitch and the outer pitch would be 1.6822, therefore the pitch corresponding to row *CC*, in this joint," indicating Fig. 1, "would be $4.4275 \times 1.6822 = 7.45$ in. The pitch of the outer row of rivets would be $7.45 \times 1.6822 = 12.53$ in. The efficiency of this joint, which would be that determined by the strength of the outer net section of plate, would be $\frac{12.53 - 1\frac{3}{16}}{12.53}$, or 90.5 per cent.

"With this joint, the safe working pressure for a 48-in. tank made of $1\frac{3}{32}$-in. plate would be, $\frac{55{,}000 \times 1.09375 \times 0.905}{5 \times 24}$, or 453.5 lb. I guess this will satisfy Casey, for I don't believe he will kick, even about the loss of the plate which represents those $3\frac{1}{2}$ lb.," said the Chief.

"If he does kick, Chief, he will have to buy the bunch a box of cigars to square himself. Is there any other practical joint that could be used on this tank, Chief, that would give better results for strength?" asked Brown.

"The only one I know that might be used, Brown, is the saw-tooth joint, which with this thick plate, might further increase the efficiency by about 2 per cent. However, despite the fact that this is known as the saw-tooth joint, it does not cut much ice with the boilermaker; the outer straps are too difficult to make."

"Say, Chief, you can improve the design of almost any of the butt-strapped joints, using straps of unequal width, in the way you have shown me, can't you?" asked Brown.

"Generally speaking, I would say yes to that question. Of course, where the plate is relatively thin for the rivet size used, the spacing of rivets in the outer rows is liable to get too wide to permit the inner straps to properly transmit the load to these rivets. In such case the benefits gained are largely a matter of figures rather than an actual increase in strength."

Vibration of Concrete Chimney

The vibration of chimneys made of reinforced concrete has been studied in Japan in connection with the great stack erected by the Kuhara Mining Co. of Saganoseki, in Kyushu, according to *The Engineer*.

This chimney is claimed to be the tallest in the world, and its main shaft rises to a height of 570 ft. Its foundation is a mass of reinforced concrete, 17 ft. thick and 95 ft. in diameter, and weighing 4714 tons. The main shaft of the chimney is tapering in form, its outer diameter being 42 ft. 8 in. at the base and 27 ft. 5 in. at the top. The thickness of the wall is $29\frac{1}{2}$ in. at the base and 7 in. at the top. The steel reinforcing rods consist of corrugated Johnson bars embedded in the concrete at a depth of 3 in. from the outer surface. The weight of the main shaft is 4852 tons. The total weight of the chimney is thus 9566 tons, of which 427 tons are steel and 9139 tons concrete. The height of the center of gravity of the main shaft above the ground is 194.2 ft., or about two-fifths of the height of the chimney.

According to an account of the experiments given by Dr. Charles Davidson in the *Builder*, so long as the wind remained below twelve miles an hour, the vibrations of the chimney top were quite insignificant, the total range of motion being well under 1/25-in. The range, however, increased very rapidly with the force of the wind. On the first day, when the velocity was 54 miles an hour, the top made well-pronounced oscillations, each about an inch in range and lasting $2\frac{1}{2}$ sec., and on the last day, when the wind attained hurricane force, the greatest range amounted to 7.7 in. As these oscillations were executed in 2.55 sec. it follows that the maximum acceleration during the movement was $22\frac{1}{2}$ in. per second, which exceeds that of a semidestructive earthquake shock.

The Electrical Study Course—Faults in Generators and Motors—II

Concludes the discussion of open-circuits in armatures and proceeds to the subject of short-circuits in them, treating of the symptoms of their presence, their detection, the tests required to determine their exact location and the cures to be applied.

AT THE conclusion of the last lesson there was under discussion the subject of open-circuits in the armature windings of generators and motors, which may be of various kinds. The simplest one, that of a single break in a coil or where the coil connects to a commutator segment, was taken up at the time. A more complicated case is the one in which two open-circuits exist either in coils adjacent to or separated from each other. Assume, for example, that open-circuits exist at *a* and *b* in the armature illustrated in Fig. 1, which is that of a two-pole machine. If the voltmeter test described in the last lesson were to be made in this case, zero voltage would be found across *every* pair of adjacent segments in testing around the commutator from *c* to *d* to the left of line *ef;* that is, there would be no two across which we would find a voltage equal to that across the brushes *cd,* as was shown would be the case when only a single break was involved. Consequently, the test described would not serve to locate the position of the fault, and a further investigation would be required to do so. Instead of testing across each two segments, as from 17 to 18, 18 to 19, 19 to 20, etc., suppose we were to test across an intervening segment, as from 17 to 19, 18 to 20, 19 to 21, etc.; when contact was made across 23 and 25 as shown in Fig. 1, the voltmeter would indicate the voltage existing across *cd* in the same manner as it did in the segment-to-segment test when there was only one break, since there is a continuous connection between brush *c* and voltmeter terminal *k* and between brush *d* and voltmeter terminal *l*. If more than two open-circuits should develop at the same time, methods similar to the foregoing would be employed for their detection.

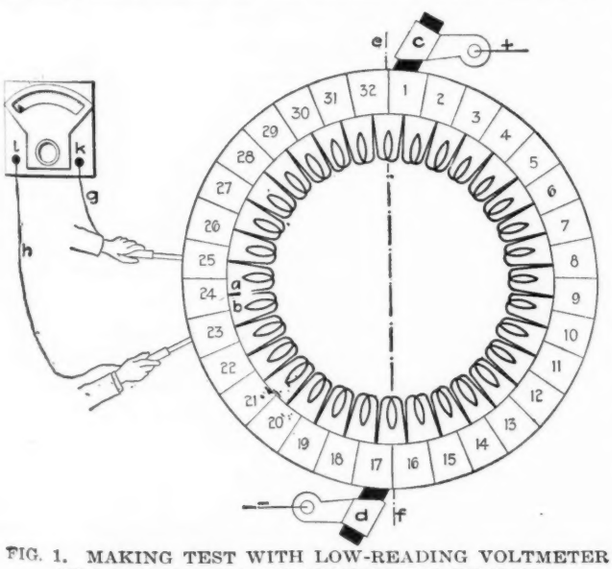


FIG. 1. MAKING TEST WITH LOW-READING VOLTMETER TO LOCATE DOUBLE BREAK IN THE WINDING OF AN ARMATURE

A case that sometimes occurs and that differs from any of the foregoing is one in which the leads from two adjoining coils, soldered into their common commutator segment, become unsoldered from the segment but remain soldered to each other. Such a condition would be represented by the break at *a* in Fig. 2. It is apparent that under the circumstances indicated there is no break in the armature winding itself and that the flow of current through it would therefore not be interrupted. Provided the brushes used are thick enough to span more than one commutator segment, which is usually the case, there would be no pronounced symptom of distress and the presence of the break would only be manifested by a probably slight amount of sparking due to a disturbance of the proper commutation conditions. Inspection would reveal location of the trouble and it would therefore be unnecessary to make any test of the circuit in this case. The cures for any of the foregoing faults would be those described in the preceding lesson, since they are identical in character, differing merely in degree.

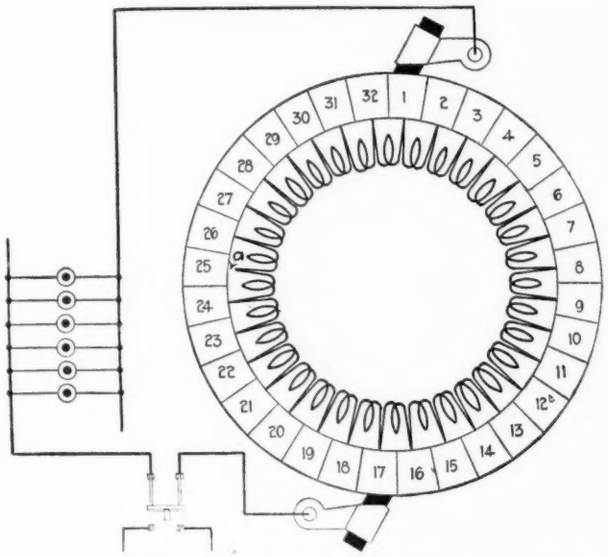


FIG. 2. BREAK IN THE CONNECTION BETWEEN TWO ADJOINING ARMATURE COILS AND THEIR COMMON COMMUTATOR SEGMENT

The next type of trouble to be considered will be that due to short-circuits in armatures. The short-circuit may be of two general kinds. In one the insulation between adjoining commutator segments fails, resulting in a partial or total short-circuiting of the armature coil spanning the segments, while in the other the insulation of a coil fails, allowing some part of one turn of the coil to come into more or less perfect contact with some part of another turn, resulting in the short-circuiting of one or more turns of the coil. In either event an excessive current will thereby be caused to flow in

the coil, resulting in severe heating which will make its presence known by the odor of the overheated insulation in the neighborhood of the coil and possibly by smoke issuing therefrom if the temperature becomes sufficiently high to cause it to burn.

The reason why a large current will flow in the short-circuited coil is apparent when it is remembered that each coil of the armature generates a voltage which in normal operation is added in series with that generated by all the other coils in the circuit of which it forms a part, to create the voltage which is found to exist across the brushes of the machine. When the coil is short-circuited, the voltage it generates causes a current to circulate within itself which is equal to the voltage it generates divided by the resistance, which is of course very low.

As an example, assume that the commutator of a 5-hp. 120-volt 2-pole motor has 32 segments and that the resistance of its armature is 0.32 ohm. Since there are 32 segments, it follows that there are 32 armature coils. Let Fig. 3 represent such an armature. It is evident that the current through it divides into two parts, one flowing from *c* to *d* through the circuit to the left of line *ef* and the other through that to the right. That is, there are two circuits in multiple between the brushes *cd*. If their combined resistance, as given, is 0.32 ohm, the resistance of each separately would have twice that value, or 0.64 ohm. The total number of coils being 32, there will be half that number, that is, 16, in each of the two circuits, and the resistance of each coil will therefore be $\frac{0.64}{16} = 0.04$ ohm. Now the voltage generated by each coil will be approximately the entire voltage divided by the number of coils in each of the two parallel circuits of the armature, which would give us $\frac{120}{16} = 7.5$ volts per coil. If, now, any one of the coils should be closed upon itself by a short-circuit, as illustrated at *a* in Fig. 4, it would be equivalent to short-circuiting the terminals of a 7.5-volt generator whose armature resistance was 0.04 ohm. The current which would flow around in the coil would take the path indicated by the arrowheads, and its value would be $\frac{7.5}{0.40} = 187.5$ amperes. This would be greatly in excess of the current for which the winding was designed, as the following computation will show:

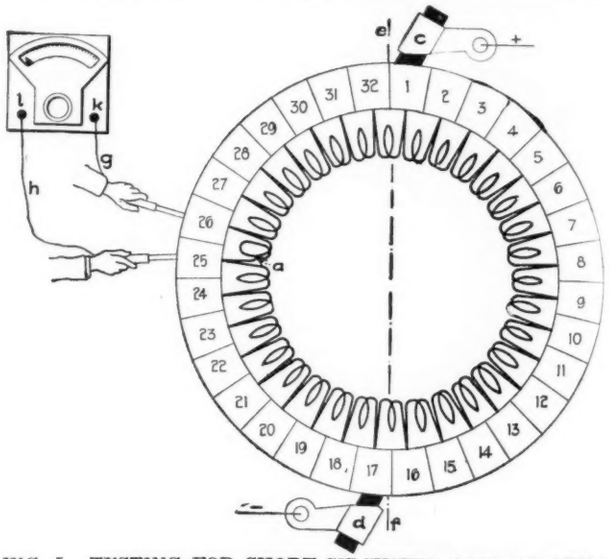


FIG. 5. TESTING FOR SHORT-CIRCUITED COIL OF ARMATURE WITH A LOW-READING VOLTMETER

The maximum output of the machine is 5 hp., which multiplied by 746 gives 3730 watts. The input would be approximately 20 per cent. greater on account of the losses in the machine, which would make the input equal to $1.2 \times 3730 = 4476$ watts. The full-load current would therefore be $\frac{4476}{120} =$ 37 amperes, which would be divided between the two parallel circuits of the armature so that less than 19 amperes would be carried by any part of the winding, as compared with 187 amperes flowing through a coil when it is short-circuited.

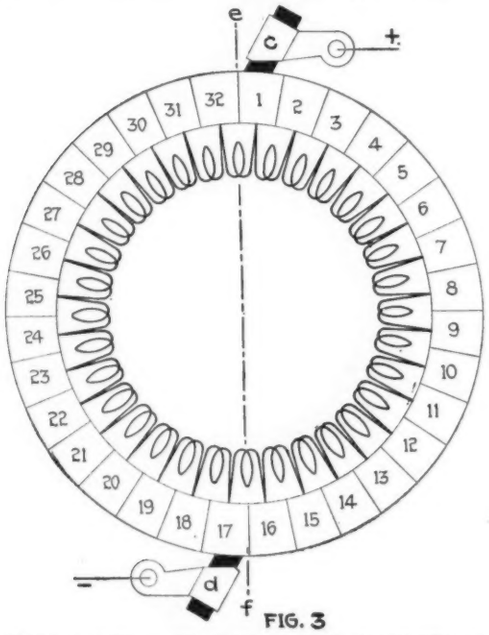


FIG. 3

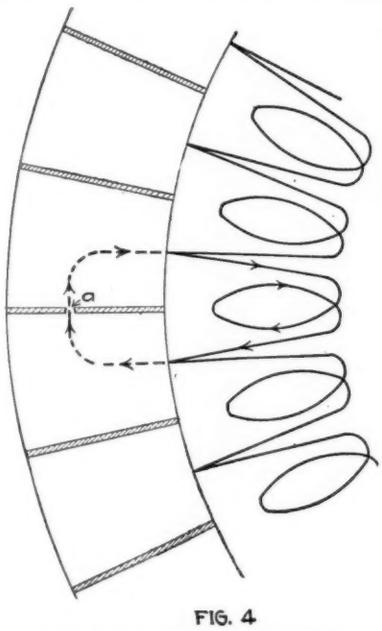


FIG. 4

FIGS. 3 AND 4. TWO PARALLEL CIRCUITS IN ARMATURE WINDING AND EFFECT OF SHORT-CIRCUITED COIL ON DIRECTION OF CURRENT

As a matter of fact a short-circuit between adjoining commutator segments generally has considerable resistance, since the conducting medium consists of a mixture of carbon and copper dust in oil or commutator compound, which works its way between the bars when the mica insulation has deteriorated for some reason, such as a flaw in the insulation itself, or some other whose source is more difficult to trace. Also when the short-circuit exists between turns of the coil, the contact resistance is generally of some magnitude. Since the resistance of the short-circuit itself is part of the resistance of the path which the current follows, it operates to reduce the flow of the current so that it seldom

reaches the extreme value it would have on "dead" short-circuit. It will, however, attain values far in excess of what the wire of the winding was intended to carry, with the consequence that it will cause severe heating, which, as previously stated, is the general symptom of a short-circuit.

When it is suspected that a short-circuit exists, mere inspection will sometimes serve to locate the coil affected. By feeling of each coil around the armature, it is often possible to determine which one it is that is considerably hotter than the rest and so detect the faulty one. If the short-circuit is between commutator segments, evidence of the fact is often given by tiny arcs forming in the space between the segments, thus indicating the presence of the connection between them. When the source of trouble cannot be located by such examinations, it becomes necessary to make tests similar in some ways to those employed in the case of open-circuits in the armature.

Testing by Voltage Drop

The usual method is to connect the armature alone to a source of voltage, placing a bank of lamps or other resistance in series with it in the same manner, as indicated in Fig. 2. Suppose that the armature so connected is that shown in Fig. 5 and that the coil which connects from commutator segments 25 to 26 is partly short-circuited as indicated at *a*. If, now, the voltage from segment to segment be tested with a low-reading voltmeter, as in the case of an open-circuit, it will be found that there is a uniform drop from 1 to 2, 2 to 3, 3 to 4, etc., throughout the part of the commutator to the right of the line *ef*. There will also be found a uniform drop, of nearly the same value, across each two segments to the left of *ef*, except across segments 25 and 26, across which there will be found a lower voltage than across the others. Just how much lower will depend on the number of turns short-circuited and the resistance of the contact at the point of short-circuit. If all the turns of the coil are cut out and the contact resistance is low, there will be practically zero resistance across bars 25 and 26, and consequently the voltage drop across them will be zero. If, on the other hand, the contact is poor, the resistance between segments 25 and 26 will be nearly as great as between any other two bars, and hence the voltage across them will not be much lower than is found across the others.

Making Temporary Repairs

Having located the coil in which the short-circuit exists, a temporary repair can be made by cutting through all the turns of the coil where it crosses from one slot to another at the back end of the armature and separating the cut ends. It will then be impossible for any current to circulate around the coil, for by cutting the coil we have deliberately produced an open-circuit in it to overcome the effects of which it is necessary to short-circuit the segments 25 and 26 as we would in the case of a temporary repair to any open-circuited coil, as explained in the previous lesson. Of course the faulty coil should be removed as soon as possible, to be replaced by a new one.

The foregoing discussions have all been illustrated with representations of ring-type armatures. This method is quite generally followed in order that the armature phenomena can be depicted with a greater degree of clearness. The circuits can readily be followed by the eye, whereas in representations of drum-type windings it is impossible to do so without a considerable amount of practice. If the theory as applied to the ring armature is thoroughly understood, its application to the drum type will be found to follow as a matter of course. The discussion also has been limited to a consideration of two-pole machines in the interest of simplicity. Whatever applies to the armature of a two-pole machine applies also to each such section of the armature of a multipolar machine as is located between successive brushes of like polarity.

Faults in Field Circuits

Open-circuits and short-circuits occur in the field windings of machines as well as in their armature windings, and the manifestation of trouble of this kind assumes the form of excessive armature currents, accompanied at times by excessive speeds. An idea of what is to be expected under different given conditions may be gained from an investigation of the internal reactions involved. For example, if in a shunt motor all the field coils are connected in series, as they are in moderate-sized machines, a break in any one coil will cause the field current to stop flowing, thus eliminating excitation and causing the machine to operate on residual flux only. If there is load upon it, the result will be to cause a tremendous current to flow, resulting in the immediate operation of the fuses or circuit-breakers protecting the supply line. If, on the other hand, the motor should happen to be running light when the break in the field current occurs, the increase in armature current would not be so large as in the other case, and if the safety devices failed to respond to the first rush of current, there would be nothing to prevent it from "running away." If all the coils were not connected in series, then there would be only a more or less serious decrease of field excitation accompanied by abnormal armature current and excessive speed.

Symptoms in Series Fields

If the machine were of the series type, the field coils would necessarily all be connected in series, and being connected in series with the armature, any break that might occur in any field winding would of itself cause the machine to shut down since there would be no flow of current through any part of it. In a compound motor the result of a break in the shunt field would be to make the machine operate as a straight series type would if it had an insufficient number of turns in its field coils. If the break occurred in the series field winding, the machine would continue to run as a straight shunt machine or shut down altogether, depending upon whether or not the series field was provided with a shunt for regulating the amount of compounding.

The tests to be applied in locating faults in field coils will be discussed in the following lesson.

In the problem of the preceding lesson it was required to find the voltage across the brushes of a two-pole motor whose commutator has 24 segments and whose armature resistance is 0.075 ohm, when it is connected in series with a resistance of 2⅛ ohms to 110 volts while the field circuit remains open; also to determine the

voltage drop that would exist from one commutator segment to the next and what voltage would be found across an open-circuit if there were one.

The total drop from brush to brush (the voltmeter leads being touched to the commutator segments upon which the brushes rest and not to the brushes themselves, so as not to include brush-contact resistance) will be the current flowing times the resistance of the armature. The current flowing, upon the other hand, would be the voltage of the supply circuit, namely, 110 volts, divided by the entire resistance of the circuit, which is the resistance of the armature plus the external resistance used, or $0.075 + 2\frac{1}{8} = 2.2$ ohms. The current consequently is $\frac{110}{2.2} = 50$ amperes, making the voltage drop across the brushes $50 \times 0.075 = 3.75$ volts. Since there are 24 segments in the commutator, there will be half that number, or 12 segments, in each direction from brush to brush, and the voltage drop across any two adjoining segments would therefore be $\frac{3.75}{12} = 0.3125$ volt. If an open-circuit exists in any coil, the voltage across the two segments spanned by the break would be the same as that across the brushes; namely, 3.75 volts.

The commutator of a four-pole 500-volt motor has 200 segments; its armature has a resistance of 1.4 ohms. Assume that a dead short-circuit exists between two of the commutator segments, and that in order to test for it a current of 16 amperes is passed through the armature. What would be the drop in voltage across adjoining bars all the way around the commutator?

Fuel Economy in the Singer Building

BY NORMAN KING†

At a meeting of N. A. S. E. engineers in New York City, Mr. King told how the boiler plant of the famous Singer Building is operated. The following article, which gives the details, should be an inspiration to other engineers.

IT IS useless for engineers to tell their managers that they are operating the boiler plants so that they are absorbing 70 or 75 per cent. of the heat in the coal. The question is, How can we prove it? I will relate our methods of obtaining results.

The boiler plant consists of four 400-hp. and one 320-hp. B. & W. cross-drum boilers, a total of 1920 horsepower. Each boiler is equipped with a superheater and automatic stop valve. The air for combustion is supplied by a large blower and is controlled by the balance draft system. The quantity of air is again regulated by the CO_2 apparatus connected to each boiler, also a pyrometer for the stack temperature. Draft gages are connected above each furnace so that each unit may have its own air regulation to obtain the best CO_2 or combustion. There are two feedwater heaters, one of the closed and one of open type. There are two feed pumps and two blower engines; the exhaust of these is controlled by their own back-pressure valves leading to the main exhaust in the engine room.

I have not mentioned the two most essential pieces of apparatus in modern boiler-room practice; namely, the stoker and feed-water regulators. The question of the stoker was taken up with some of the best-known stoker manufacturers, and it seemed to them that our case was hopeless. No engineer can appreciate what an essential thing it means to feed his boilers regularly, until he sees a chart from a flow meter. The steam-pipe throughout is double-covered and there are no steam traps on the high-pressure lines; this is taken care of by the Holly-loop system.

The recording instruments in this plant are in constant use. They are as follows: Flow meters to measure the individual boiler horsepower, horsepower-hours and evaporation, as units in themselves; draft gages for draft above the fire and pressure in ashpit; recording CO_2 apparatus on each boiler with a pyrometer; recording back-pressure gage on the feed-water heaters; recording thermometer in the feed-water line leaving the closed heater, also a thermometer in the feed pumps, showing the temperature of the water coming from the open heater; recording thermometer for the steam and superheat; a recording pressure gage; a bomb coal calorimeter.

GRADE OF COAL AND METHODS OF HANDLING

Up to the latter part of the year 1915 this plant burned No. 2 buckwheat at the usual market price. After consideration we decided to use a cheaper grade of fuel, which necessitated changing our grates, cutting the air space from 30 to about 8 per cent. These grates were designed and installed under each boiler by our own operating force, which meant considerable saving in installation and fuel cost, which netted a yearly saving of over $500. We follow up our boiler setting, going as far as making asbestos joints in furnace doorframes, side and back connection doors, and filling in wherever there might be a possible chance of air infiltration. These conditions in this plant are lived up to every day.

The feed water is heated in two stages: First, in the main open heater, it is brought to the feed pumps at 208 to 210 deg. F. or the heat due to back pressure, which is seldom over one pound; then the water is pumped through the closed heater. The exhaust of the blower engine and feed pumps passes through this heater, where the back pressure is raised 5 to 7 lb. For the loss in power due to the excess back pressure on these auxiliaries, we have raised the feed-water temperature to an average of 228 deg. F. This increase in feed-water temperature shows a saving of about 2 per cent. on the total fuel.

The coal is taken by the trolley from the bunkers to the scales and weighed, entered on the log sheet against the boilers.

*How do you operate your plant to make every B.t.u. do its utmost? If it's worth telling about, send it in and help save that 50 million tons of coal.—Editor.

†Assistant to the Chief Engineer.

Our method of firing is first to regulate the air supply through the fuel bed to give the best CO_2 results. It is furnace draft we regulate, and is the difference in pressure between the ashpit and the furnace, which is almost constant with the balance draft system from a clean fire to one 12 in. in thickness, at which thickness they are cleaned. The furnaces are fired alternately, one-third of each furnace at a time, always keeping two-thirds in good condition to keep up the temperature. This method showed an improved superheat chart and a better CO_2 average than with other firing methods.

The thickness of firing is best governed by the pressure carried in the ashpit, which is about 1 to $\frac{1}{10}$ in.; spotting and leveling has to be done from time to time. The life of a fire under these conditions with good coal is from 7½ to 8 hours; with poor coal, from 4 to 4½ hours. The operation of cleaning is done by hauling the clean fuel onto the dead plates, burning down the entire grate surface, dumping, and leaving the grates clean, pushing back the clean fuel and covering with fresh coal. By the time the ashes are removed the boiler is steaming again. The total average time for complete operation is 29 minutes.

The boilers in this plant are operated about 75 to 85 per cent. of their rating and are worked above rating only when other boilers are being cleaned. I have experimented from time to time to see how long it would take to increase the boiler-horsepower output 100 per cent. with hand firing under our conditions. With the feed valve closed it took 58 sec. and with feed valve slightly open, 1½ min., showing that the heat was in the furnace when the demand was made. At night the load is at its lowest. I have operated one boiler for a week under the same load and coal heat value, one boiler being able to carry the night load; running two boilers under the same conditions, it cost 1400 lb. more coal.

The contract price of the coal was $2.75, but the price was raised, which brought the yearly average to $3.05. The following daily averages are for 365 days:

Cost of coal, per ton	$3.05
Coal per day, tons (2220 lb.)	21
Evaporation, lb. of water per lb. coal	8.4
47,040 lb. of coal per day	$64.05
395,136 lb. of water per day	6.32
71 cans of ashes removed per day @ 5 cents	3.55
3 firemen per day	7.50
3 coal passers per day	6.00
1 boiler cleaner per day	2.33
1 boiler-room cleaner per day	2.33
Supplies and repairs	1.56
Chief engineer's supervision	0.26
Assistant engineer's supervision	0.13
Total	$94.03

Average operating cost for the year to produce 1000 lb. of steam equals $23\frac{7}{10}$ cents.

The boiler efficiency given below is taken under good coal conditions from a boiler operating 24 hours; this is not to be considered a boiler test; the figures are taken from our daily records on a 400-hp. boiler using No. 3 buckwheat coal:

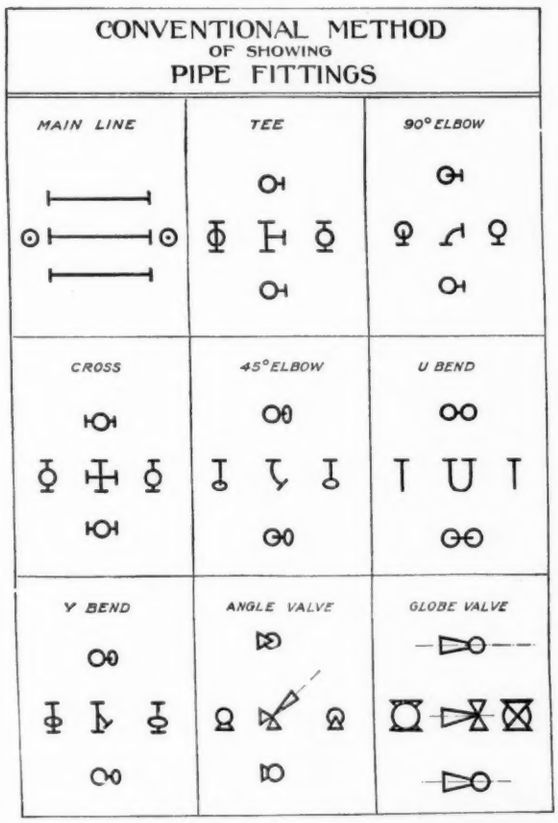
Total coal consumed in 24 hours, lb	22,994
Average pounds of coal per hour	958
Commercial B.t.u. per lb. of coal	11,799.4
Ash, per cent	14
Water evaporated per 24 hours, lb	202,347.2
Water evaporated per hour per lb. of coal	8,431.1
From and at 212 deg. F., lb	8.8
Steam pressure, lb	150
Superheat, deg. F	50
CO_2 per cent	13
Temperature of gases leaving boiler, deg. F	400
Excess air, per cent	59.2
Boiler horsepower developed	279.2
Boiler rating, per cent	70
Pounds of coal per b.hp	3.4
Combined efficiency, per cent	78

Lens Region Much Damaged

With our knowledge of German methods it was to be expected that nothing would have been left undone to render the coal region about Lens of as little value as possible to the Allies when the recapture of what was one of France's main sources of coal supply was seen to be inevitable. From Paris word now comes, according to the *Engineering and Mining Journal*, that it will be from eighteen months to two years before any coal can be taken from the mines in the devastated area, owing to the damage done by the enemy before his retirement. After an examination of the properties, it has been estimated that five years will be required to restore the normal production of the pits.

The inspection was made, according to the dispatch, by Albert Lebrun, the Minister of Blockade, and Louis Loucheur, the Minister of Munitions, together with M. Perier and M. Basly, chairman and vice chairman, respectively, of the Committee on Mines of the Chamber of Deputies. They visited Lens itself and the adjoining mining towns of Sallaumines and Lievin. They found the mines flooded in these localities, and although every possible measure to restore the operating plants has been taken by the state, it will be two years, it is estimated, before the mines can be cleared of water. The mining plants have been systematically destroyed, the destructive process having been carried to the limit.

At Courrières, northeast of Lens, the Germans had blown up the mines before retiring. Of the 10,000 houses in Lens the visitors found not one left standing, the town having been completely razed.



The illustration above shows the symbols used to designate the most commonly used pipe fittings, in making single-line drawings of a piping layout. When drawings are to be executed as rapidly as possible the single-line drawing is a great time saver. There is little chance for mistaking one symbol for another.

The Fuel Cost of Heat and Power

BY F. H. ROSENCRANTS*

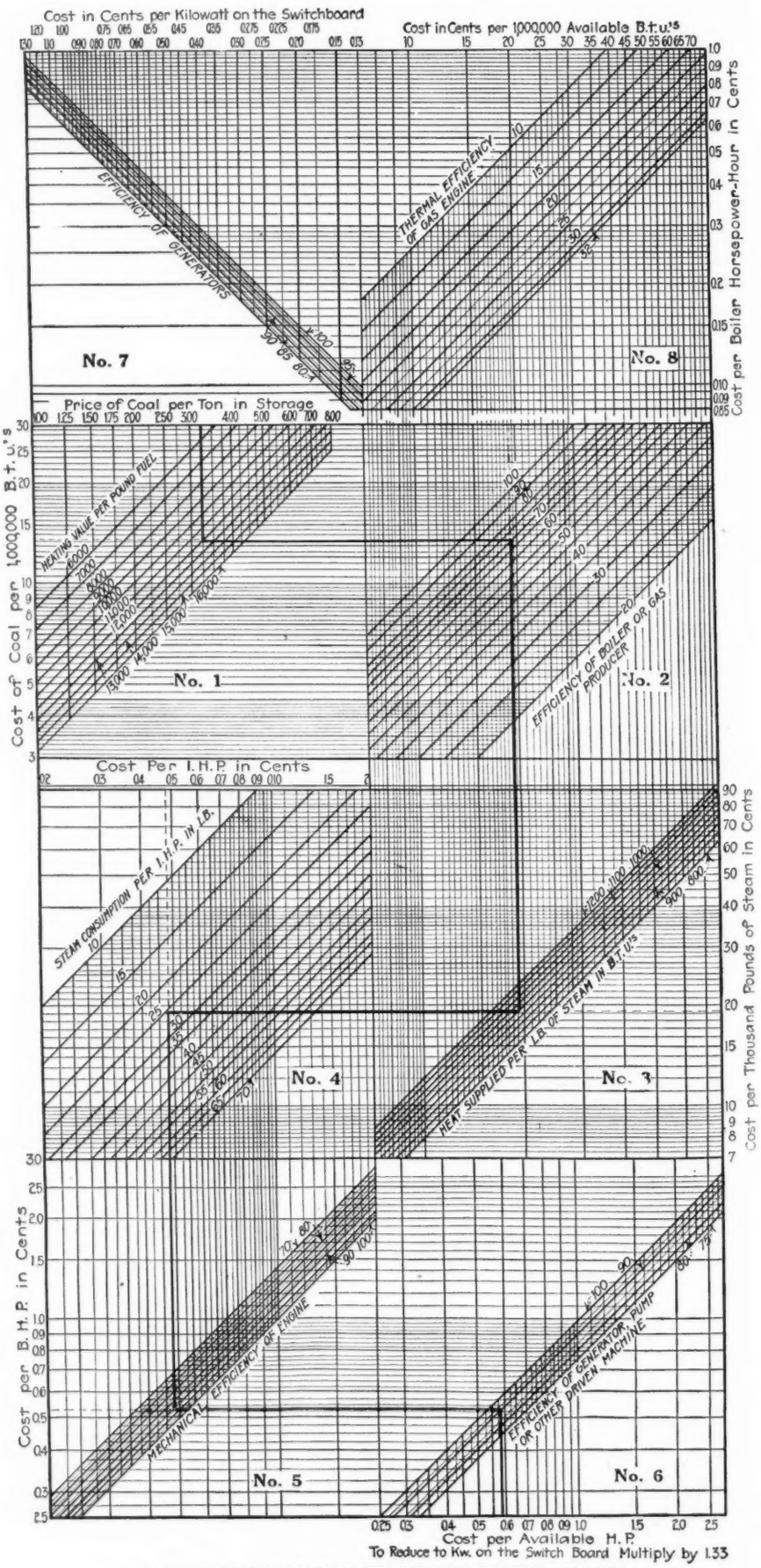
The accompanying chart is composed of eight panels numbered for convenience. The method of using the chart may be best illustrated by the solution of a problem.

Beginning at the top of panel No. 1, with the *price per ton of coal in storage* ($3.25) drop down to the *heating value per pound fuel* (12,000 B.t.u.) and proceed to the left to *cost of coal per million B.t.u.* (13.6c.) or proceed to the right to *efficiency of boiler or gas producer* (70 per cent.), panel No. 2. From this point proceed vertically to *cost in cents per million available B.t.u.* (19.2) or drop down to *heat supplied per pound of steam in B.t.u.* (1000), panel No. 3. From this point proceed to right to *cost per thousand pounds of steam in cents* (19.2) or proceed left to *steam consumption per i.hp. in pounds* (25), panel No. 4. From this point proceed vertically to *cost per i.hp. in cents* (0.48) or drop down to *mechanical efficiency of engine* (90 per cent.), panel No. 5. From this point proceed to the left to *cost per b.hp. in cents* (0.53) or to right to *efficiency of generator pump, or other driven machine* (90 per cent.), panel No. 6. From this point drop down to *cost per available hp.* (0.58).

Panels Nos. 7 and 8 are for use in case of a producer-gas plant and with an understanding of the foregoing explanation I believe the method of use is clear.

The flat top and bottom of the U. S. standard thread is produced by simply grinding off a certain amount of the point of the thread tool. The theory of the round top and bottom is that the corners of the tap will wear off anyway, after a little use, and you had better do this when making the tap. However, the trouble with the theory is that the flat topped tap stands up well and gives no trouble in practice.—*Marine Engineering.*

*Engineer, Texas Power and Light Co., Dallas, Texas


Cost in Cents per Kilowatt on the Switchboard
Cost in Cents per 1,000,000 Available B.t.u.'s
Cost per Boiler Horsepower-Hour in Cents
EFFICIENCY OF GENERATORS
THERMAL EFFICIENCY OF GAS ENGINE
No. 7
No. 8
Price of Coal per Ton in Storage
Cost of Coal per 1,000,000 B.t.u.'s
HEATING VALUE PER POUND FUEL
No. 1
EFFICIENCY OF BOILER OR GAS PRODUCER
No. 2
Cost Per I.H.P. in Cents
STEAM CONSUMPTION PER I.H.P. IN LB.
HEAT SUPPLIED PER LB. OF STEAM IN B.T.U.'S
Cost per Thousand Pounds of Steam in Cents
No. 4
No. 3
Cost per B.H.P. in Cents
MECHANICAL EFFICIENCY OF ENGINE
EFFICIENCY OF GENERATOR PUMP OR OTHER DRIVEN MACHINE
No. 5
No. 6
Cost per Available H.P.
To Reduce to Kw. on the Switch Board Multiply by 1.33

FUEL PERFORMANCE CHART FOR POWER PLANTS

EDITORIALS

Iron Pyrites in the Coal

UNDER the ruling of the National Fuel Administration, power stations cannot purchase coal from whatever coal fields they choose, but must obtain it from the zone designated by the Fuel Administration. This ruling does not prevent the purchase of certain grades of coal from the zone in which the plant is located, but there is no certainty that the coal ordered will be the coal that is delivered to the company that ordered it. This is because a pooling system is used at many terminal points.

Both the zone system and the pooling of coal at terminals have their advantages. The zone system, as is well known, prevents the coal mined in a distant field from being hauled to its destination past a coal field that is many miles nearer the plant where the coal is to be used. In this way the rail mileage for coal cars is greatly reduced, and the railroads are able to haul more freight of all kinds.

Pooling avoids the confusion and delay at terminals which was caused by the necessity of picking out from thousands of cars those containing a particular assignment and getting it aboard the barge or wagons of a particular consignee. All the coal is pooled and each consignee supplied out of the common store with as nearly as may be the kind of coal ordered by and consigned to him.

There is this disadvantage: The quality of the coal received may be inferior to what has been used, and occasionally this causes trouble. For instance, certain districts served by the Marion and the Essex stations of the Public Service Corporation of New Jersey were without street illumination and a number of industries were without power for several hours one day recently. This power shortage was due to the delivery of coal from the pool that contained considerable sulphur and iron pyrites. When burning the coal, these impurities caused the grates to clog with a clinker that was so different in character that the ordinary methods of treating it were ineffective, and as a sufficient amount of air could not get into the furnace, the rate of combustion dropped to such an extent that the total output of the two plants, about one hundred and sixty thousand kilowatts, was reduced about twenty-five thousand kilowatts.

An interesting feature of the trouble is that the character of the deposit formed somewhat resembled hard, flinty glass and that although five types of stokers are found in these two stations, all were affected in like manner, and one type gave as much trouble because of the clinkers as another.

Fortunately, such a streak of coal is not frequently encountered, but inasmuch as these plants have had their output reduced on account of the clinkers clogging the stokers, it is probable that other plants will receive similar coal. Of course, the experience of the Marion and Essex plants is not the only one. Others must have had similar troubles. Why not tell *Power* readers about them?

A Clean Army as Well as a Brave One

AMERICANS rightly take considerable pride in the knowledge that our fighting men are second to none in the matter of personal bravery. They should be equally proud in the knowledge that our armies are morally the cleanest the world has ever known.

This condition of moral cleanliness is not an accident. It is the result of the safeguards that are thrown about the soldier from the moment he leaves home for the training camp or the cantonment. It is due to the ceaseless, ever-present, untiring work of the welfare organizations that have extended their influence and their activities into every military locality from the home camps to the front-line trenches.

These organizations supply many of those things which our soldiers in previous wars sadly lacked. They furnish places where the boy may write letters to his home folks on stationery that costs him nothing, see moving picture shows, hear helpful lectures, attend church services, play games, engage in gymnastic exercises, read books and magazines, continue his studies under competent direction and in scores of other ways mitigate the bareness and alleviate the hardship of military life.

Through these various diversions and activities the soldier is prevented from brooding over his condition or his misfortunes, and his spirit is kept normal. In short, his morale and that of his comrades is maintained. Pershing himself has testified that the ministrations of the welfare organizations add ten per cent. to the effectiveness of the fighting men who come under their influence.

Here, then, is ample justification for the United War Work Campaign during the week of November 11 to 18 for the purpose of raising $170,500,000 to carry on and extend the work of the Young Men's Christian Association, the Young Women's Christian Association, the National Catholic War Council, the Jewish Welfare Board, the War Camp Community Service, the American Library Association and the Salvation Army.

Events in the theater of war are happening with startling rapidity. Peace may be concluded within an unbelievably brief time. But though the fighting may end this month or this year, the needs of the welfare organizations will continue until every last man has returned to his home and his occupation. The periods of demobilization and of reconstruction will be filled with demands upon these societies for the sort of service they are so admirably fitted to give. Therefore, the obligation rests upon everyone to contribute liberally to these organizations, that their splendid work may not be hindered or embarrassed through lack of financial support.

What is An Engineer?

AFTER serious study and consultation with eminent authorities, A. H. Krom, Director of Engineering, United States Employment Service, has prepared a new definition of an engineer.

"An engineer is one who economically directs man power and by scientific design utilizes the forces and materials of nature for the benefit of mankind," says Mr. Krom, in an endeavor to produce a practical, workable statement that will be of real value to technical men and employers of technical men.

Even before this pronouncement, however, we had a belief that the engineer had something to do with the utilization of the forces of nature. The matter must have had much the same aspect in the mind of Tredgold when he wrote his famous definition of civil engineering as "the art of directing the great sources of power in nature for the use and convenience of man . . ." Mr. Krom completes this by adding the economical direction of human labor and the utilization of materials as well as forces.

Of course, it is well that everyone should understand what an engineer is and does. But it is probable that the world has already formed a fairly sound opinion on the subject, through appreciation of what engineers have done and are doing in the present war.

Making an Impression on the Waster of Coal

FACTS strike home to you only when they are clothed in such language as you can readily comprehend. Speak of a man as an impecunious representative of the piscatorial species and he will probably think you are paying him a compliment. But call him a poor fish and you will doubtless start something.

You have been trying to impress upon your firemen the necessity for reducing the coal consumption in your plant. You have used all the posters, folders, tracts and bulletins that have been printed and you have added your personal exhortations, yet you feel that the results are not what you have a right to expect.

Did it ever occur to you that there are as many grades of mentality as there are individuals, and that as a consequence your method of campaign may fail wholly to appeal to your men? Have you tried a different way of accomplishing the desired end?

You have told your man that it is a patriotic duty to save one ton in every five. This is true, but it presents patriotism as an abstract thing, and firemen are not deeply interested in the abstract. Why not make patriotism practical by pointing out what can be done with each ton of coal saved?

Tie that ton of coal to the war work. Tell your men that it will produce twenty thousand good cartridges, which the marksmanship of our doughboys will convert into a respectable quota of good Germans—that is, dead ones. Show them that a ton of coal is equivalent to four hundred bayonets—the kind that have been vigorously prodding Fritz in the rear during his long retreat from the Marne.

Point out that a ton of coal will make two hundred and fifty helmets to protect our boys, carry ten soldiers across to France, move a fifty-car freight train fifty miles or build two tons of shipping, and that every one of these is a form of valuable assistance in the war program. Anyone but a pro-German ought to be inspired by the possibility of rendering such service to the country.

If the appeal to the patriotism of the men fails, try to reach them through their sense of money values. Ask any fireman whether he would deliberately throw a ten-dollar bill into the furnace every day. He knows he wouldn't unless he happened to be drunk. But you can show him in a moment that if he wastes twenty per cent. of the coal he handles in a day, he burns up the equivalent of that ten-dollar bill and makes a lot of unnecessary work for himself in doing it. Emphasize the point that it is your money he is wasting and that you cannot pay increased wages with the smoke of ten-dollar bills.

Lacking improved results from this line of attack, try another. See whether you can touch the pride of the men in their abilities as firemen. A little rivalry or competition often works wonders in results. At any rate don't give up too soon. Study the men and endeavor to find the particular quarter in which an appeal for economy is likely to be most effective.

If all your various expedients fail, there is a last resort. You can translate your firemen into fired men. Much coal is being wastefully burned and improvements are possible. If you cannot obtain them with your present working force, perhaps you can with another.

The Effort Begins To Bear Fruit

THE Fuel Administration announces that the efforts of engineers and plant owners to conserve fuel show a saving of three-and-a-half million tons of coal for the first six months of concerted effort by those concerned. But the more cheering part of the announcement is that this saving has been made chiefly by improved methods instead of most by the installation of new equipment. That is, this saving has been effected by engineers and firemen. They have been awakened to the need of saving coal, and have more closely applied the knowledge they have of how to do it, and made use of the information currently set forth telling them how to do it.

The achievement is one of which engineers and firemen may be proud, despite that there is still room for considerable improvement. Power plants have not been free from the troubles due to inexperienced labor, labor turnover and loss of engineers into the country's armed forces.

The result achieved should be the greatest encouragement; it should stimulate power-plant men to try to quadruple it.

An unusual and encouraging recognition of the engineer is the dedication to the late Henry Floy of the Yosemite Power Plant, for which he made the preliminary study and report, and by his arguments before the Appropriations Committee of the House of Representatives procured the appropriation.

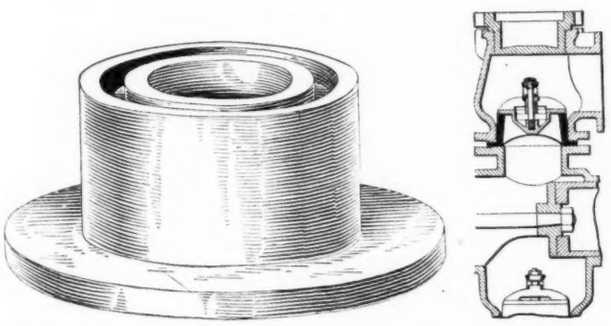
Get the habit; use the back damper.

CORRESPONDENCE

In these and other columns "Power" wants to tell how you have decreased the fuel consumption in your plant. Since the fuel shortage, engineers have been thinking hard about conserving fuel. Thousands have made changes in equipment, in operating methods, and in modifications to boiler settings, etc., all of which have, in many plants, greatly cut fuel consumption. You owe it to the country to tell your fellow-engineers how you have saved coal. "Power" will pay for good articles that will help the other fellow save coal as you have saved it. Engineers must save at least 35 million tons this year. Let's have your story.

Improved Pump-Valve Seat

The illustration shows an improved pump-valve seat that I have been using for a year and find satisfactory on pumps in a mine shaft. The water is high in sulphur and soon eats the valve seats out where the water discharges over the outer edge of the seat. I find that turning a groove in the valve seat and filling it with



PUMP-VALVE SEAT GROOVED AND FILLED WITH SOLDER

solder, half lead and half tin, will prolong the life of the seat 50 per cent. At the left in the illustration the removable seat with the groove is shown and at the right its position in the pump. Perhaps this will help some engineer, in return for many helps I get from *Power*.

Eriton, Penn. G. M. PIERCE.

The Engineer and the Boiler Inspector

Your editorial in the issue of Sept. 10 and Mr. Taylor's article on page 389 regarding boiler inspection are timely and directly to the point. I have long since learned to appreciate the boiler inspectors and always welcome them to my plant and give them all the assistance within my power; for when one of them can be persuaded to "open up," there is something worth while coming to any engineer or manager. My experience with inspectors proves them to be gentlemanly and courteous, and I am at a loss for reasons why some operating engineers treat them so "shabbily."

I am proud of my plant and appreciate suggestions and the boiler inspector's interest in helping to maintain it in a safe working condition. I believe in boiler inspection and boiler laws and their enforcement. Next to an engineer's license I believe in licensing boilers. Wherever the two have been worked together they have been successful. I wish I could induce all engineers to give the boiler inspector the "glad hand," ask him questions, make friends with him and increase their own store of knowledge thereby. I have never come in contact with a boiler inspector without learning something of real value, and it seems strange that some plant owners and engineers look upon him as a nuisance.

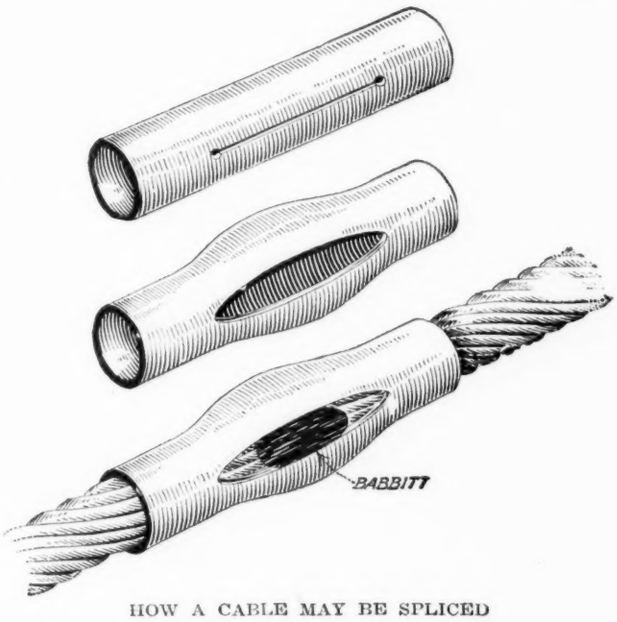
It may be disagreeable work to "get the plant ready" for the inspector, but keeping a plant in this condition at all times means the saving of coal—one of the big items in winning this war. L. G. BURR.

Dayton, Ohio.

One Way of Splicing Elevator Cable

Recently, while installing a new operating cable on one of our elevators, I found that a short piece had been "spliced" in. It had been simply tied in with several bulky knots.

A better and at the same time more workmanlike way would have been to use a piece of pipe about eight



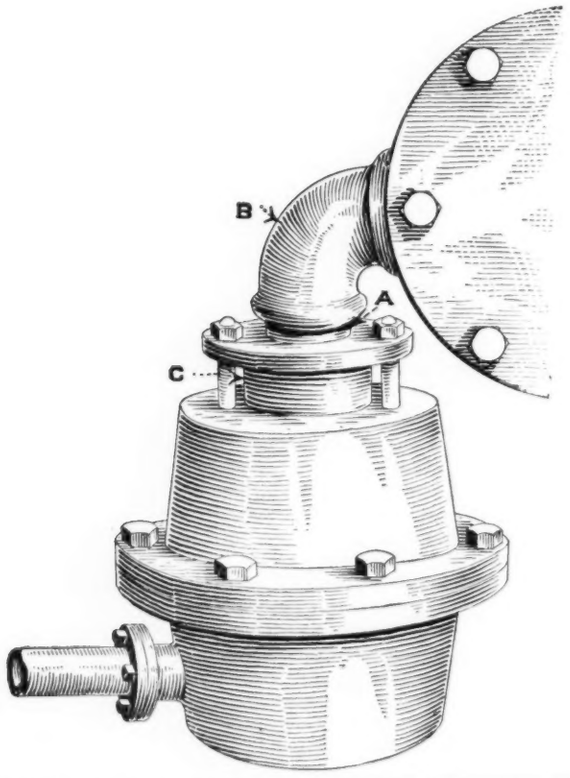
HOW A CABLE MAY BE SPLICED

inches long and of a size large enough to allow the cable to enter easily. Slit this pipe for about four inches and spread the halves with a chisel, as shown. Put the ends of the cable in the ends of the pipe and spread the strands. Then pour on hot babbitt. A simpler way is to drill a number of holes and pour the babbitt; but this does not make as strong a job.

Woodhaven, L. I. RALPH. J. DALTON.

Noisy Gas-Engine Exhaust

An engineer was once sent to locate and remedy a gas-engine trouble. The owner, who did not pretend to know anything about gas engines, said that the engine ran pretty well, but kept firing out in the "dashpot" and that he thought there must be a broken valve or spring. The engineer was at a loss to know what



EXHAUST PIPE TO MUFFLER BECAME DISCONNECTED

was meant by the "dashpot" on a gas engine, but afterward found that it was the muffler. After looking the engine over and seeing nothing wrong, he asked that it be started up. It started easily, but there was enough noise from the exhaust for two or three engines.

The engine was equipped with a cast-iron muffler, as shown in the illustration. Upon examination it was found that the nipple *A* had worked out of the elbow *B* and dropped down, allowing the exhaust to escape through the small opening between the face of the elbow and the stuffing-box gland *C* on the muffler. The nipple was replaced, and when the engine was again started it operated without excessive noise.

New York City. P. A. GETT.

Tar in Gas Producers

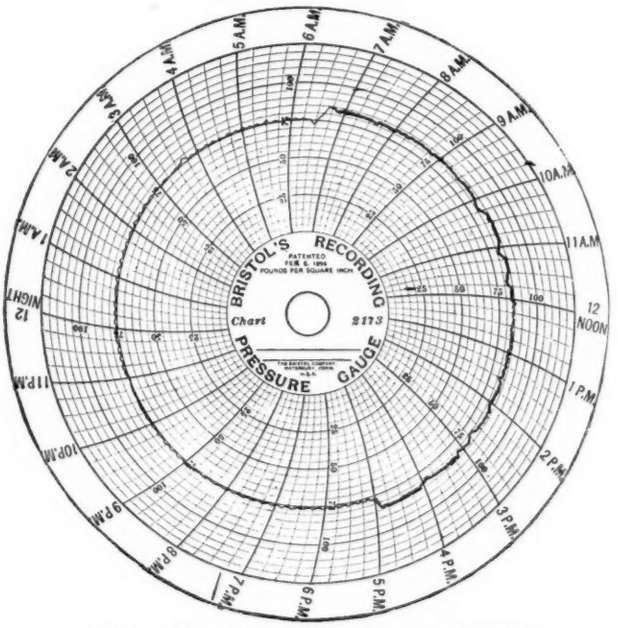
Your article in the Aug. 6 issue on the Ford City producer-gas plant does an injustice to the Highland Park plant at Detroit. All of the wonderful problems were thrashed out at the Highland Park plant, where the operator of the Ford City plant received his training before that plant was ready for lighting of the fires. As early as August, 1917, the tar was burned by the tank method, but it was found that the calorimeter showed an increase in the heating value of the gas of from 30 to 45 B.t.u., dropping back to its former value as soon as the tank was emptied. To flatten out these peaks in the heating-value curve, which were quite pronounced, a steam-jacketed pump was installed to handle the tar. By this means the variation in quality of the producer gas was remedied.

As to the steam jacket for the tar line, the experience here at Highland Park has been that too hot a device has the effect of baking the tar on the hot surface. A much better way is to run the tar and the steam lines separate, but under one cover. If the tar to be disposed of all came from the tar extractors it would seldom be necessary to warm it, but when burning the tar recovered from the primary condensers there is a considerable quantity of combustible carbon (wet coke dust) which has a happy (?) faculty of lodging where you do not want it to lodge; and if this mixture is not properly respected, it will cause a lot of worry. Heating lines for this work should never have more than 3 lb. steam pressure. A. CLARK LISCOM.

Detroit, Mich.

Who Does Better?

In the issue of Oct. 8, page 540, Mr. Steele shows a chart from a recording steam gage. I am inclosing one that I think answers the question. During the time this chart was made the load varied from 400 to 850 amperes electric output, an extremely variable air-compressor load and a heavy heating load. The feed water is regulated by hand and the temperature varies from about 175 deg. at night to 210 deg. during the day. Power



SPECIMEN CHART FROM REGULAR FILES

is used only during the day and the exhaust does the heating, with a small amount of live steam for process work where higher temperature is required. At night the only exhaust available is from the boiler-feed pump and the heating-system vacuum pump.

Reducing valves admit steam to the heating system when the engines are stopped, 2½ to 3 lb. pressure being carried. The equivalent of about seven miles of 1-in. pipe is used for supplying heat, the farthest point being about 450 ft. from boilers. The return-tubular boilers

are 72 in. x 18 ft. and 66 in. x 17 ft. equipped with "hand stokers" set 30 in. below the shell in front and 48 in. in the back, with low bridge-walls, giving a fair combustion space although not what I would have if setting new boilers. We have a damper regulator attached by rods and links to the stack damper, and each boiler has its own damper, but these are generally wide open unless the fire is banked, which is usually done on one boiler each night alternately. The damper regulator is set at slightly lower pressure at night, as can be seen on the chart.

The night fireman also acts as watchman in the building, making periodical trips which take him from boiler room for about half-hour periods. The firing is done at rather extended intervals, the coal being fired just inside the door in large quantities (400 to 600 lb. at a time) and, after coking, is worked down the grate by levers, making it unnecessary to open the firing doors very often. We hope to get draft gages shortly and possibly a gas-analysis apparatus, but at present our only aids to steady and economical firing are good grates, a good damper regulator and, most important of all, good firemen.

HARRY H. YATES.

Trenton, N. J.

All-Around Blundering Conduct

The article on page 568, in the issue of Oct. 15, entitled "All-Around Blundering Conduct," is a fair example of the "all-highest" attitude adopted by some superintendents and chief engineers toward their subordinates. Such an attitude is resented by any man with even the backbone of a jellyfish and seems to be the essence of the "Prussianism" which we are at present endeavoring to overthrow across the waters.

Men of this character (and there are many) have no place in a free country, in a position to affect the destiny of good men by tyrannical "ukases." It is often within the power of a superintendent, by giving or withholding a good word, to affect the life of a fellow employee (from an industrial standpoint) for a period of years, and materially hamper his struggles for advancement.

The methods employed by the disgruntled day engineer to discredit his successor were entirely reprehensible and disgraceful. It would have been better to have handed in his resignation when demoted to night work without explanation, and thereby at least have "saved his face" if not his job.

It is often difficult to determine the boss's sentiments toward oneself, as he may take offense at what he considers *lèse majesté*, whereas the unlucky offender is entirely unaware of his "crime" until the boss begins to try to "ride him off the job" "for the good of the service," leaving the impression that the man was either incompetent or negligent and that he had been contemplating letting him go for some time, when in reality it was personal animus and not inefficiency that caused it.

After a good many years of worrying about whether the boss was going to fire or promote me, I have decided in every case to do my work as nearly right as possible, to strive for smooth and economical operation, and if the boss (whoever he may be) thinks otherwise let him get his pay clerk busy.

I am thankful that all bosses are not of this ilk, but during my experience in eight or nine different plants and under fifteen or sixteen different chief engineers and later superintendents and managers, I have found about 40 per cent. of them to be more or less of that character.

I remember an experience some years ago while working as night engineer in an electric plant. I had secured a two weeks' leave of absence (without pay), and the day I was leaving town accidentally met the manager who, in the course of the very casual conversation, remarked that the chief, who had been there only about six months, was a very competent man and that he considered him the best man he had ever had. Imagine my surprise to find, upon my return two weeks later, that the chief and the day engineer had both been fired, and the manager in a "kettle of hot water" trying to avoid a shutdown, as the man on nights was the only one left who was capable of standing a watch.

What was the trouble? The manager did not like the day engineer and had suddenly fired him without consulting the chief. The chief naturally resented this, so the manager fired him, too. Later, trying to justify his action, he said that the former chief was not even a first-class oiler and was the poorest excuse for an engineer that he had ever been unfortunate enough to obtain. Of course the firing was merely a piece of hot-tempered foolishness, but why attempt to blacken the engineer's reputation afterward?

This is but one of several similar instances I have known and only shows how petty some people can be even though they hold positions of responsibility. We see a lot about how to treat the boss, to gain and retain his favor; why not a little on how to treat the subordinate to gain and retain *his* favor without which no organization can have the full measure of success?

Memphis, Tenn. R. BRUCE.

Wiping Commutators

Mr. Watson's comments on wiping commutators, on page 573 in the issue of Oct. 15, has brought to mind some of my own experiences in the care of direct-current motors and generators. I agree with him as to lubrication, only we use vaseline in place of oil, in the manner he describes.

I have come to the conclusion, after some trying times with various graphite brushes, that it is best to use the brushes specified by the makers of the machine as suitable for the grade of copper in the commutator. Some manufacturers have a plate put on the machine giving the catalog number of brushes to order by. I am also an advocate of slotted commutators if the speed is high enough to keep the slots from filling with particles of carbon and copper. Two of our machines were continually giving trouble and needed frequent turning and sandpapering, but since having the mica under cut and keeping the commutators and brushes clean and sparingly lubricated with vaseline, sparking and burned segments are things of the past, and as Mr. Watson says, "prettier commutators than ours are hard to find."

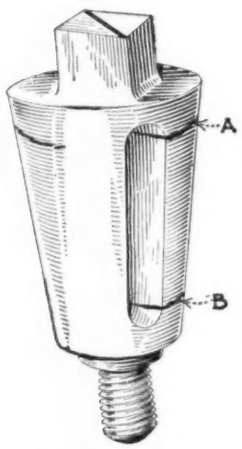
Vibration in high-speed d.c. machines is another source of commutator and brush trouble. On a 200-ampere 125-volt motor-driven exciter set the commutator gave trouble with either graphite or carbon brushes.

The machine stands on the floor, with no other foundation, and upon examination I found the floor slightly higher in the center than at the ends of the bedplate, allowing it to rock slightly when running. Thin wooden shims under each end of the bedplate and slotting the commutator cured the trouble. If the speed is high and the mica a trifle high, the brushes will be thrown away from the copper and sparks will result which in time will burn and blacken the commutator. Slotting will overcome this even if there is considerable vibration. The wear on our commutators and brushes is hardly noticeable, and they are never touched with sandpaper. One machine is a 250-ampere 575-volt motor-driven street-railway generator carrying a considerable overload.

Jefferson City, Mo. J. A. WATKINS.

Boiler Blowoff Valves

Experience makes me differ with many, including R. B. Dale in the issue of Oct. 15, page 565, as to the relative positions of the plug-cock and the valve in tandem on a boiler blowoff pipe. In the plant of which I have charge there are four boilers connected with the blowoff arrangement as shown by Mr. Dale, but the first time I blew down I nearly blew myself up. When I turned the plug-cock to close it, I did not find very great resistance, but noticing that it was leaking, I gave it a gentle tap on the top and tried to tighten the nut at the bottom; to my surprise it leaked more. Having 80 lb. of steam pressure on the boiler, I did not go any further, but secured the plug from flying out with a piece of wire and let the fire under that boiler burn out and cut it out, and the next day I drained it. Upon examining the plug, which was 2-in. all brass, I found it almost parted in the place marked *A* and cracked at *B*. I changed the position of the cock so that it was after the valve instead of before it and at the first opportunity examined the other plugs and found two of them in the same condition. I altered the connections on all the boilers so as to have the valves next to the boilers.



BROKEN BLOW-OFF PLUG

I believe this arrangement is much safer than the other, as a good valve seldom becomes dangerous even if the usually weak part, the disk or stem, gives out.

I am somewhat "shy" of the asbestos-packed cocks which depend on two or four small bolts to hold the plug in place. These bolts may look sound, yet may be corroded at the shank and may part at any time.

Jamaica, N. Y. A. FISH.

Since reading the article by R. B. Dale on page 565 in the issue of Oct. 15 I have looked in the A. S. M. E. Boiler Code and fail to find any reference to the relative position for the valve and cock on the blowoff pipe of a boiler. In fact the Code does not require the use of a cock at all and leaves it optional; two valves or a valve and a cock may be used. It does, however, state that if used "a bottom blowoff cock shall have the plug held in place by a guard or gland." Personally, I refer a screw valve next to the boiler. The order of opening and closing may be the same in either case.

It certainly gives one a "creepy" feeling to see the condition of some blowoff cocks, especially when it is realized that the full boiler pressure may be acting, to blow the plug "skyward," on an area equal to the big end of the plug and only perhaps two small bolts of questionable character to oppose. It is true, of course, that when a plug-cock is in perfect condition there is no tendency to force the plug out of its socket, but when there is leakage around the plug and the outer valve is tight, the pressure "gets in its work" on the end of the plug below. This applies to the type of cock having the body closed at the bottom.

I hope others will "speak up" on this subject.

New York City. J. LEWIS.

Testing the Polarity of a Circuit

In Mr. Watson's letter, "Methods of Testing Polarities of Circuits Without Voltmeter," on page 464 in the issue of Sept. 24, it is stated that if a current is passed through a glass of salt water, the fewer number of bubbles arising at one pole will indicate its polarity to be the positive one. I have used this test and sometimes with unsatisfactory results. For instance, when the amount of current passed is great—as when the voltage is high or when sufficient resistance is not at hand—it is unsatisfactory, for bubbles will then rise from both poles in considerable numbers. A more reliable method is to proceed as Mr. Watson suggests, but attach to each wire a piece of clean lead. After a short period the positive will turn a reddish brown, while the negative will turn grayish.

There are many other ways of testing polarity, such as the observation of two arc-lamp carbons immediately after turning off the current. The positive will be the hottest one and therefore the brightest. Or if a paper is moistened with iodide of potassium and touched with the two terminals, the positive one will leave a brown mark. All these tests, however, involve the use of some device or apparatus, and it often happens, as in the field, that none of these means is available. The simplest test possible is to stick the ends of the wires into some moist substance, preferably a potato, apple or onion in the order named. Boiling or bubbling will occur at the negative terminal.

It is sometimes necessary to distinguish between an alternating- and direct-current circuit. In this event none of the tests mentioned can be used, for the action would be similar at both terminals. There is, however, an easily distinguishable difference between the arcs produced by the two. Upon breaking or interrupting an alternating-current circuit the arc will only sputter and is easily extinguishable; while with a direct-current circuit under the same conditions the arc will have a tendency to stream across and produce a pronounced hissing sound. If an incandescent lamp be connected in series through a condenser on an alternating circuit, the lamp will light because of the surges induced in the plates, but owing to the interposed gap of the condenser, the same arrangement on a direct-current circuit will not produce light. H. C. HOPPER.

Passaic, N. J.

INQUIRIES OF GENERAL INTEREST

Proportion of Grate Opening for Coal Burning—What should be the proportion of grate opening for burning anthracite? J. G.

For admission of sufficient air, the clear open spaces should constitute about one-half of the total area of the grate. If they constitute a greater proportion of the grate area, the cooling effect of the air causes slow and imperfect combustion of the lower layers of fuel, too much air will be admitted and the furnace efficiency will be lowered.

Payment for Coal Containing Excess of Moisture—If the contract price of coal is $6.50 per ton, and guaranteed not to contain moisture in excess of 2 per cent., what price should be paid per ton of coal delivered that contains 6 per cent. of moisture? P. H.

On the contract basis, the price of a ton of dry coal would be $6.50 ÷ 0.98, and if the coal furnished contained 6 per cent. moisture, or only 94 per cent. of dry coal, the price paid should be $6.50 ÷ 0.98 × 0.94 = $6.23 per ton as delivered.

Relations of Diameters and Speeds of Pulleys—What is the rule for finding the diameter required for a driven pulley of given speed, when the diameter and speed of the driver are known; and for finding the diameter required for a driving pulley of given speed, when the diameter and speed of the driven are known? A. D. M.

When there is no slippage and the effect of belt thickness is neglected, the diameter of the driven pulley multiplied by its speed is equal to the diameter of the driver multiplied by its speed.

To find the diameter of the driven pulley, multiply the diameter of the driver by its r.p.m. and divide by the r.p.m. of the driven.

To find the diameter of the driver, multiply the diameter of the driven by its r.p.m. and divide by the r.p.m. of the driver.

Factor of Evaporation, Equivalent Evaporation and Boiler Horsepower—A boiler evaporated 298,125 lb. of water in 24 hours from a feed temperature of 212 deg. into dry saturated steam at 150 lb. gage pressure, using 28,500 lb. of coal. What is the equivalent evaporation from and at 212 deg. F. and what was the boiler horsepower developed? R. G.

According to the steam tables a pound of dry saturated steam at 150 lb. gage, or 165 lb. per sq.in. absolute, contains 1195 B.t.u. above 32 deg. F., and with feed water at the temperature of 212 deg. F., each pound of the feed water must have received 1195 — (212 — 32) = 1015 B.t.u. Evaporation from and at 212 deg. F. requires the latent heat of evaporation at that temperature, or 970.4 B.t.u., and therefore the factor of evaporation is 1015 ÷ 970.4 = 1.046; and as the evaporation under actual conditions was 298,125 ÷ 28,500 = 10.46 lb. of water per pound of coal, the equivalent evaporation was 10.46 × 1.046 = 10.94 lb. of water from and at 212 deg. F. per pound of coal. The accepted boiler horsepower is equivalent to evaporation of 34.5 lb. of water from and at 212 deg. F. per hour, and therefore the capacity developed was (298,125 × 1.046) ÷ 24 × 34.5 = 376.6 boiler horsepower.

Trouble from Riveted Piston Becoming Loose—What is a good method of fastening the piston of a 10 x 12-in. engine on the piston rod. There is not sufficient piston-travel clearance to allow for a rod with screwed end and nut for holding the piston in place. The bore of the piston is tapered and countersunk for receiving the tapered and riveted end of the rod, but trouble has been experienced with the piston working loose and it will not stay tight for re-riveting? A. H.

It is likely that the original tapered bore and tapered end of the rod were not well matched or else that the piston was not pressed firmly on the rod when the rod end was riveted.

Remove the piston and rod from the engine, and if the piston is not up against a shoulder on the rod, try to pound the rod tighter into the piston and after re-riveting the end of the piston, set a screwed dowel of about one-fourth the diameter of the rod so it will be half and half in the end of the rod and hub of the piston. If the piston again becomes loose in ordinary service, it will be because entire refitting of the tapered end of the rod and of the bore will be required. For obtaining sufficient length, after allowance for taper and riveting, a new rod may be required.

Setting Exhaust Valves of Double-Eccentric Engine—What is the method of setting the exhaust valves of a double-eccentric Corliss engine? S. D.

See that the rocker-arm which is connected with the eccentric rod vibrates approximately equal distances on each side of its normally central position for a complete revolution of the eccentric, obtained either by revolution of the shaft with the eccentric fast on the shaft or by slipping the eccentric around on the shaft. Most Corliss valve gears are designed to obtain central position of the rocker when the center line of the rocker-arm is at right angles with the eccentric rod. The vibrations of the rocker to each side of the intended central position can be equalized by lengthening or shortening the eccentric rod, but precision of this adjustment is not of serious importance, excepting that the length of the eccentric rod must be fixed before making other adjustments. Next observe whether the swing of the wristplate, or bell crank, for operating the exhaust-valve rods is as far to one side of its central position as to the other during a complete revolution of the eccentric.

Most engine builders place a mark on the hub of the wristplate, or bell crank, that comes opposite to a mark on a stationary flange of the stud when the hub is in the central position, and the length of the hook rod is to be adjusted to obtain the same travel of the mark on the hub either side of the centering mark on the stud. Next remove the back bonnets from the exhaust-valve chambers. The circular end of each valve should have a mark that comes opposite to a mark on the end face of its valve chamber when the opening edge of the valve is line on line with the opening edge of its port. With the wristplate, or bell crank, in its central position, adjust the length of the exhaust-valve rods so the marks on the ends of the valve indicate that both valves are just closed. Having set the valves evenly with the wristplate, to obtain 5 per cent. compression of the exhaust, turn the engine so as to place the piston within about 5 per cent. of the end of its stroke from either end, and turn the eccentric around on the shaft in the direction the engine is to run. Then secure the eccentric to the shaft in such a position that the wristplate is central and the exhaust valve in the end of the cylinder that contains the piston would remain closed for forward motion of the engine.

The valve setting should be tested by taking indicator diagrams when the engine is carrying its average load. If better equalization of compression in opposite ends of the cylinder is desired, it is to be obtained by adjustment of the length of the valve rods, and if conditions require earlier release and more compression, the eccentric is to be set farther around the shaft in the direction of rotation.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Condensers and Condenser Engineering Practice—I*

By D. D. PENDLETON

ON TURBINE work a proper condenser is vitally important to secure high economy, and is nearly as important on reciprocating-engine propositions, although a noncondensing engine is more possible than a noncondensing steam turbine. After generating steam economically by well-designed boilers and stoker equipment, high efficiency of the prime mover is obtainable only by using a well-designed and properly selected condensing equipment.

The choice of a condenser should depend upon the individual plant conditions. In a recent issue of a prominent trade journal one of the largest condenser manufacturers in the country says: "The selection of a condenser always narrows down to a study of individual plant conditions. Our past experience with the three types of condensers (surface, low-level jet and barometric) proves that judgment should in every instance be based on a thorough investigation of individual plant requirements and conditions. A preference for or a prejudice against one type over others, not resting on sound investigation, will prove the solution to be unsound and the result unsatisfactory."

How Choice of Condenser Should Be Governed

The choice of a condenser should be based on the nature and quantity of water for condensing, the vacuum, and the auxiliaries. A consideration of the condensing water should include the quantity available, the average temperature, the pumping head, the kind of water (whether acid, clear, muddy, etc.) and the source.

If the water quantity is unlimited and temperature, say, 70 deg. average, a ratio of 83.3:1 and a 28.5-in. vacuum is the practical limit in the proportioning of a surface condenser, standard practice being 61.5:1 ratio for 28-in. vacuum.

A 58:1 ratio and same vacuum is the practical limit in low-type jet or barometric machines, standard practice being 38.2:1 ratio for 28-in. vacuum.

This is a ratio of practically 40:1 for all three types of condensers, basing same on 5-deg. difference, which for 27-in. vacuum is the smallest amount of water possible to be used. This reduces the pumping cost against cooling tower and spray nozzle head and keeps the size and cost of tower and pond down to a minimum.

A surface condenser when operating with a cooling tower or spray, would have approximately a 30-ft. head for the tower or spray alone, plus friction through the condenser and system, which we will assume to be 15 ft., or a total of 45 ft. The jet condenser will have the same cooling tower head, plus the static lift from the water discharge nozzle of the condenser to the cooling tower level, usually not less than 15 ft.; and in addition to this, a vacuum back pressure of at least 30 ft. Eliminating the friction, we have 81 ft. for the jet and the same quantity of water. The circulating pump on the surface condenser, when properly designed, can be figured at an efficiency of 75 per cent., making a total net operating head of, say 60 ft. Assuming that a tail pump on the jet condenser will have an efficiency of only 50 per cent. with an 81-ft. head, a total operating head of 162 ft. would be required. If the tower were designed for 4000 gal. of water per min., the figures given would represent the horsepower of the pumps alone, which means 170 per cent. more power for operating a jet than a surface machine with cooling tower or spray system.

The vacuum practical to maintain also depends upon the type of prime mover. A reciprocating condensing steam engine is seldom proportioned for more than from 26 to 27 in., whereas a properly designed steam turbine should be so designed as to properly utilize the highest theoretical vacuum obtainable under all conditions as to water temperature.

A study should be made as to the type of auxiliaries, such as circulating water pumps, air removal apparatus, in the three types of condensers, and condensate pumps in the surface type. These are usually steam- or motor-driven. The air is sometimes removed by a steam jet.

Barometric Type of Condensers

For a barometric condenser the water requirements are usually figured on a 5-deg. temperature difference—that is, as I have said, the final temperature of the water being within 5 deg. of the temperature of the vacuum. Properly designed machines have been known to work practically at no temperature difference, thus giving a 100 per cent. water efficiency, which is sometimes called condenser efficiency. Where very bad, dirty or acid water only is available, the barometric lends itself admirably to the situation. The sprays or plates in the head of the condenser must pass dirty or bad water without clogging and a cast-iron body resists admirably the action of acids. The steam after being condensed in a barometric condenser is lost, and the condensate is not available for boiler-feed purposes, having been mixed with the condensing water. When this is extremely bad, a supply will have to be secured from some other source, either by purchasing same, or by treating with chemicals. The barometric tail pipe, or leg of the condenser should be large enough to positively carry off all water and debris by gravity without clogging. This type is the most fool-proof of all.

Where the exhaust piping is under, say, 4 to 5 ft. in diameter, an installation can be made well within practical possibilities for high duty up to slightly more than 28.5-in. vacuum. With exhaust piping above 5 ft. in diameter, difficulties as to first cost, erection, air leaks and other physical troubles are encountered and where this high duty is desired the possibility of air leaks is very much increased and loss in vacuum in the exhaust piping is also usually high, due to friction.

Location of Hotwell or Overflow

The hotwell or overflow from the barometric tail pipe should be placed high enough so that the water can at all times flow by gravity to the sewer or back to its source. If the source is a river with high and low water variations, it should be placed above high water levels.

The pumping head for a barometric condenser would be a starting head equal to the lift from the source of water level to the water inlet nozzle and an operating head of the same distance minus the vacuum suction, this being usually figured at about 20 to 25 ft. When a cooling tower or spray system is used, a separate pumping unit will have to take water from the hotwell and pump it over the tower or through the sprays. Where the source of water is at a constant level, the total head need be only a few feet more than the distance from hotwell level to water inlet, but where the source is at a variable level, the total head will vary accordingly.

The amount of air to be extracted from a barometric machine equals the sum of the air entering with the steam and the air entering with the water, which is immediately liberated from the water particles upon its entrance to a vessel under vacuum. The volume of air depends upon the vacuum and its temperature, and the temperature depends upon the point from which the air is taken from the vessel.

A barometric condenser is especially suitable when a basement or a pit is not possible to be placed under the prime mover, or where the exhaust from engine or turbine is above the floor line of the power house.

*Abstract of paper presented at the twelfth annual convention of the Association of Iron and Steel Electrical Engineers, Baltimore, Md., September, 1918.

A low-type jet condenser, although more complicated than a barometric condenser, sometimes lends itself more practically to an installation than the barometric.

The water quantities of a low-type jet condenser are figured exactly upon the same basis of the barometric—viz., upon a 5-deg. difference with a possibility, under proper conditions, of obtaining a 100 per cent. water efficiency.

Low-Type Jet Condensers

A low-type jet condenser has the same advantages and disadvantages as the barometric, but care should be given to the design of its discharge or tail pump, which is to take the place of the barometric column or leg, so that it will at all times keep the outgoing water ahead of the incoming water.

The limit as to size of a low-type jet condenser presents quite a study from an engineering standpoint. Practically, all low-type jet condensers of the larger size are intended to be placed beneath the prime mover—in most all cases, steam turbines. A single jet condenser of 10,000 kw., or say 140,000 lb. of steam per hour, seems to be the practical limit. Basement requirements, foundation requirements, multiplicity of auxiliaries, and impossibility of arranging with spares; exhaust-nozzle connections, and complications of air and water piping, form an important problem which should surely be studied very closely.

The pumping head for a low-type jet condenser would be the vacuum back pressure plus any stated head outside of the tail-pump nozzle, plus any friction. The vacuum back pressure and friction through check valve which is usually required on the discharge nozzle of the pump for 28-in. vacuum, is usually figured at 36 ft. The water is drawn into the condenser by the suction of the vacuum—never put in under pressure—against a suction lift of never practically over 18 ft. A valve should be placed in the suction line to regulate supply. A vacuum breaker should be placed on the condenser to break the suction in case of failure of the tail pump or its inability to keep ahead of the injection water to prevent flooding of condenser, turbine or engine. When the source of water is within this 18-ft. suction lift, no other equipment for water supply is required; but when not, a booster pump is supplied to pump from the source of water to a cold well within reach of the suction line of the condenser. This head, of course, is in addition to the head on the tail pump.

Hotwell of Low-Type Jet Machine

The hotwell of a low-type jet machine, of course, is immediately below the condenser, and the discharge or tail pump, which is usually submerged in it, will have to pump the water away from the vacuum. If the discharge nozzle of the tail pump is higher than the maximum high water no other head will be required, but if not, it will have to pump against an extra head equal to the difference in elevations and, as in the case of a cooling tower, or a spray system, against the cooling tower or spray system head.

The amount of air to be extracted from a low-type jet can be considered somewhat less than from a barometric, owing to possibilities of having fewer joints in piping to keep tight, the air coming in with steam and water being the same.

Surface-condenser water requirements are based on 5, 10, 15, and 20 in. difference, which, with 70-deg. circulating water and 28 in. vacuum, is a ratio of 38.5:1, 47.6:1, 62.5:1 and 99:1 for each 1000 B.t.u. A 15-deg. difference or a 62.5:1 ratio is usually considered standard. Water quantities available and pumping head usually determine which to select.

When very bad water only is available the question of using a surface condenser becomes serious and a complete study should be made of the practical, theoretical, or other advantages or disadvantages, due consideration being given the loss of condensate or the consequent purchase or treatment of water for boiler-feed purposes, and even the action of treated water on boiler tubes, which also affects the fuel economy of boilers.

There is no limit as to size of a surface condenser. They are now made in sizes from 50 sq.ft. of surface up to 75,000 sq.ft. This latter size is capable under proper rating and design, of condensing 600,000 lb. of steam per hour of 1000 B.t.u. per lb. Most surface condensers for large power plants are placed under the steam turbines, an expansion joint being placed between turbine and condenser in sizes up to, say, 66-in. exhaust nozzle. For larger sizes the condenser is usually mounted on springs with expansion joints on auxiliary piping.

The pumping head on a surface condenser is the actual static head, plus friction through piping and condenser, minus the siphon effect when the discharge from the condenser is sealed within the proper siphon leg limits or, say, within 20 ft. The friction loss through a well-designed two-pass condenser, which is the usual type, is generally from 5 ft. to 8 ft. and if the source of water is within 20 ft. of the discharge nozzle and the discharge is sealed, the total head through condenser and piping should not be over 15 ft. This varies according to conditions.

The water is usually pumped through the tubes at a velocity of from 5 ft. to 7.5 ft. per sec. In the case of a cooling tower or spray system, a closed circuit is formed from reservoir, tower or pond through the condenser back to the tower or nozzles, thus only requiring a pumping head equal to the friction losses in the system plus the tower or spray system head.

A hotwell, immediately beneath the condenser is usually furnished in which to collect the condensate which is pumped from the condenser against the vacuum back pressure to the boiler feed-water heater or storage for boiler feed. This condensate, being pure distilled water, is always reclaimed for boiler-feed purposes. A head of from 40 to 75 ft. is usually figured against which the condensate is pumped, depending upon conditions.

Air in Surface Condensers

The air-removal requirements for a surface condenser are less than for any other type. Air infiltration with the water is eliminated and only air entering through air leaks in piping or with the steam is considered. In standard practice it has been assumed that a surface condenser entrains only one-half as much air as either the barometric or the jet machine. The power requirements for all auxiliaries on a surface condenser are decidedly less than on any other type under the same conditions.

Regarding the much-discussed subject of water velocities for surface condensers, eminently good engineers have advocated as high as 10 ft. per sec., stating emphatically that 8 ft. is conceded to be practical and standard. Since from tests of well-known large condensers a water velocity of 4.7 ft. per sec. seems to be the average, we will assume 5 ft. Now, suppose that this velocity is increased to 8 or 10 ft., you can readily figure the excessive power requirements for such conditions. All talk of 8 to 10 ft. per sec. seems to be absurd in view of the fact that there are very few commercial plants in practical operation under this condition.

Horsepower Should Vary as the Cube of Velocity

By plotting the curve of head lost in the condenser, against the discharge in gallons per minute on logarithmic paper, it is found that the head lost varies as the 1.75 power of the discharge, but since the velocity varies directly as the quantity of water, we conclude that the head lost varies according to the 1.75 power of the velocity. This exponent is but slightly lower than the exponent 1.87 given in the "American Civil Engineers' Pocket Book," or the exponent 2 generally conceded as an average value. As the water horsepower depends upon the quantity times the head, the horsepower should vary as the cube of the velocity. It is found, by plotting the water horsepower curve, that the exponent is 2.9; that is, the horsepower varies as the 2.9 power of the gallons per minute, or of the velocity through the condenser tubes. Assuming a water velocity of five feet per second, and 30,000 gal. per min., by increasing this velocity to 10 ft. per sec., the head loss in the condenser would be 35 ft., making a total of 52 ft. instead of 10 and 15 ft., and a water horsepower of over 800 instead of 112.

The amount of surface for a surface condenser is figured on a certain rate of heat transfer per square foot per mean degree difference between the mean water temperature and the temperature of the vacuum to be attempted. There is little, if any, practical improvement in heat transfer due to increased water velocity through tubes. Theoretically, there is quite an improvement in heat transfer, but practically, the disadvantages due to increasing the velocity and consequent power requirements so overbalance the advantages that we can see no reason for materially increasing the velocity.

Heat Transfer in Surface Condensers

The question of heat transfer in surface condensers has been widely discussed, and in all the tables the heat transfer has been figured at approximately 300 B.t.u. per sq.ft. per mean degree difference.

Three hundred and fifty B.t.u. is, I believe, now standard by high-class manufacturers. Some manufacturers recommend as high as 400 or 450, or even 500. Proportionate reductions in the surface and margin of safety will be made as the rate of heat transfer is increased. In a well-designed and well-laid-out surface condenser, the purchaser certainly has a greater margin of safety with the surface based on 300 or 350 B.t.u. than with a higher rate.

At high vacuum the specific volume of steam becomes enormous—339.6 cu.ft. under a 28-in. vacuum and 1259 cu.ft. under a 29.5-in. vacuum—and the addition of surface or baffles to a condenser of ordinary design may entirely defeat the purpose of the designer because of the increased resistance to the flow of steam between the tubes and through the condenser. Particular attention should, therefore, be paid to providing steam lanes, or to the proper arrangement of tube banks, so as to keep down this resistance of flow to a minimum. In some well-known cases, removal of 10 to 20 per cent. of the tube surface has materially increased the vacuum.

A primary surface heater is sometimes placed in the path of the incoming steam so that the condensate can be pumped through it and by so doing bring the temperature of the condensate up to the temperature of the vacuum. Otherwise, the temperature of the condensate can be kept high, in the installation of a standard surface condenser, only by sacrificing some features of the design of the condenser itself. This is accomplished by arrangement of steam lanes and other special features, usually resulting in a short-circuiting of the steam to auxiliaries, and steam and noncondensate vapors being driven into the air-pump suction or condensate pump suction, causing trouble and a loss of condensate. When a hydraulic pump, or steam jet, is used, overloading it and decreasing capacity and duty on the main unit results. The air removal devices act as small jet condensers in these cases.

Care and Management of Steam Plants

The following rules to be observed and suggestions on the care and management of steam plants have been made up by W. D. Cole, power engineer of the American Can Co., New York City, for the use of the Kings County Fuel Committee:

Brickwork of boilers should be kept in good condition. Firebrick on externally fired boilers should never be allowed to burn through to the red brick. Repairs should always be made before red brick is exposed to the direct heat.

Smoke tests should be made when boilers are hot, at least once every month, for openings or cracks in settings. There are several kinds of plastic preparations on the market for the repairing of these cracks.

Boilers fired with soft coal, tubes should be blown out with steam every day. If fire tubes, run brush or scraper through once a week. When hard coal is used, blow tubes once a week and scrape once a month.

In internally fired boilers, combustion chamber on back connections should have soot removed and swept clean every week.

Breeching, flues, etc., should be examined or tested for air leaks at regular intervals.

All boilers should be equipped with fusible plugs.

Boilers equipped with underfeed stokers, tu ere blocks should be examined at regular intervals and repaired at once if holes appear in same larger than the regular openings.

All feed-water lines to boilers should have thermometers attached and so located that they can be as easily read as the steam gage.

Plants with open heaters, feed water should be from 208 to 212 deg. F. With closed heaters, 200 to 206 degrees.

Feed pumps taking water from open heaters should have cold-water supply valve, bypassed with ¾-in. pipe with ¾-in. needle valve in same.

Cylinder oil in boilers should be considered positively dangerous and removed whenever the slightest trace appears.

Water columns should be blown down every day. If water columns have valves in connection to boiler, handwheels should be removed from the same and kept in a convenient location.

All valves in pipe lines should be examined at regular intervals to see if they require reseating or renewing.

Remove cylinder heads and steam-chest covers from all steam cylinders and inspect same at least every six months.

Also chock flywheel of engine with head removed and turn on steam to test piston and valves for leaks.

Remember that all uncovered surfaces in your power plant that allow heat to radiate to the atmosphere cause a waste of coal.

During the heating season allow no exhaust steam to escape to the atmosphere through the exhaust pipe or otherwise. If you have more exhaust steam than you require to heat buildings and feed water, try to sell it to your neighbors.

Remember that a good vacuum pump on heating returns will work wonders in the distribution of low-pressure steam.

Take a candle and hold it in front of the smallest crack in your boiler setting. Instantly you will see the flame bend inward by the rush of air that is pouring through the cracks. If you can see it with the smallest crack, just stop to think how much cold air is passing through the larger ones continually, never stopping, every second the boiler is in operation.

The application of an air-tight blanket composed of a good plastic material on all brick-set externally fired boilers is a paying investment. The same can be said of the application of an asbestos covering to internally fired boilers.

Your boiler setting is a brick room, designed to hold the heat that transforms the water in your boilers into steam. The temperature of this room varies from 1500 to 2000 deg. F. The temperature in the boiler room is about 80 deg. The draft that is pulling the flue gases up the chimney is also pulling this 80-deg. air into the inside of your boiler setting where it chills the hot gases of 1800 deg. that have been created through the burning of coal. The result is that you must burn just that much more coal to keep the temperature up to where it should be.

Every time you save a shovelful of coal, you add one more shovelful to the pile and you have added the cost of that shovelful to the profit of the business.

Graphite Restrictions Modified

Restrictions on the importation of graphite have been modified by the War Trade Board in the following order:

No licenses for the importation of amorphous graphite (plumbago) shall be issued hereafter, except such shipments as are of Canadian origin and come overland or by lake from Canada, or of Mexican origin and come overland from Mexico.

Licenses may be issued for the importation of graphite of crucible grade when the applications therefor are otherwise in order, and where the chemical section of the War Industries Board has approved the issuance of said license, and has certified that the ultimate consumers of the said graphite have been using at least 20 per cent. of domestic or Canadian flake graphite in the manufacture of their products.

Henry Hencken, a retail coal dealer of New York City, has been required to pay a fine of $1000 for violation of the ruling that no individual consumer could receive more than two-thirds his normal coal requirements for the present. Hencken delivered full requirements to certain customers for cash payment. The amount of the fine has been transmitted to the New York County Chapter of the Red Cross.

Fuel Saving by Industrial Plants

Through the coöperation of the industrial power plants, which have thus far put into force the standard recommendations of the United States Fuel Administration to promote efficiency in the use of fuel, a saving of 7,000,000 tons annually has been effected. That is to say, in the first six months from the announcement of the national program, 3,500,000 tons have been conserved, at the same time maintaining maximum production in the factories. The largest savings have been in Massachusetts, Pennsylvania, Connecticut, Illinois, New York, Missouri, Michigan, Minnesota and Wisconsin.

Some industrial plants which have adopted the standard recommendations and kept systematic records report a fuel saving as high as 25 per cent., and the average is estimated between 10 per cent. and 15 per cent. This large economy is effected at practically no expense to the plant owner since the recommendations treat primarily of proper methods of firing and management in power plants.

One manufacturing plant in Abbeville, S. C., writes the Fuel Administration that as a result of the installation of the improvements and records recommended, "We show for the first eight months of this year a fuel saving of over 25 per cent. as compared with the same eight months last year."

A Fuel Administration campaign comprehends voluntary service by engineer inspectors, lectures to fuel conservation classes in educational institutions, addresses before public meetings, explanations of the program to power-plant owners, and various forms of printed matter and posters.

For the efficient execution of the program of industrial conservation, under the plan developed, the engineers of the country have been mobilized through the professional societies and the operating engineers and firemen, and as a result there are today fifteen hundred volunteer engineer specialists and power-plant men organized by states, inspecting power plants, classifying them according to their operating efficiency and aiding the work of rapid development. As a direct result of the operation of this plan, it is estimated that the total annual saving throughout the country will be about 25,000,000 tons of coal without reducing the output of the factories. Special printed material, instructing on the proper use of fuel, has been prepared by the United States Fuel Administration and may be obtained free of cost upon application.

The campaign has been organized in consultation with the state administrators, the Bureau of Mines, and the Committee of Consulting Engineers of the Engineering Council, which represents the four national engineering societies. These four societies have contributed largely in supplying expert advice of engineering talent; special relations have been formed between the Fuel Administration and the National Association of Stationary Engineers, the International Brotherhood of Stationary Firemen and Oilers, the Laundry Owners' National Association, the Portland Cement Association, and other national bodies which have given full coöperation to this national plan.

Light and Power on Big Scale

The magnitude of everything about the new Boston Army Supply Base is amazing, says the *Boston Transcript*. As an example, the electrical equipment of the plant is one of the biggest electrical contracts ever let in the country. The Edwin C. Lewis Co., which has the contract, furnishes the following facts regarding the material and work to be done by the concern.

Over forty miles of overhead line work have been installed in order to supply temporary lighting to enable the workmen to work at night and also to furnish power for over 1000 hp. motors used for operating wood- and iron-working machinery, concrete mixers, hoists, etc.

For temporary illumination at night, lamps totaling over 500,000 cp. are used, these varying from 50-watt house lamps to 1000-watt flood light projectors.

A temporary power station is installed containing large converters capable of transforming the alternating current to direct current for capacity of 400 hp. for working special apparatus and hoists for use in building operations.

For permanent current supply an independent line carrying 15,000 volts is under construction direct from the L Street Station of the Edison Co. to the new power plant. This line will terminate in three large transformers, each over 11 ft. high and 6 ft. in diameter. These transformers lower the voltage to 2300 volts, which is then distributed to 12 large transformers located in different sections of the building..

To supply current to the various buildings from the street lines over twenty miles of underground ducts are being installed. In the building proper more than eighty miles of iron conduit is being installed, all wiring being concealed in these conduits.

In the permanent powerhouse, two rotary converters of 1500 hp. are being installed, these to furnish direct current to be used in operating traveling cranes and hoists for unloading ships along the 2000 ft. of waterfront opposite the wharf shed. Over 2000 hp. of electric motors are to be used on the freight and passenger elevators. Three powerful fire pumps will be driven by 100-hp. electric motors for fire protection.

The material will be handled locally through the storehouse by means of electrically operated trucks. In order to provide for the charging of these, six independent charging stations are provided in the main storehouse, each of which contains two 25-hp. rotary converters to transform the alternating current to direct current for charging the batteries that operate these trucks.

British Steam-Power Economies

According to the British Government *Board of Trade Journal* of Sept. 26, there have been four hundred experts appointed by the coal controller to consult with and advise steam power users how to avoid waste. As the result of an inquiry by the Coal Control Technical Department, it is clear that tremendous wastage of coal is going on which could be prevented with improved equipment. It will, however, take several years to stop the whole of this loss, even if a supreme effort is made by all industrial firms, as it is impossible to install more efficient plants while the war is on. Another cause of wastage of coal is the employment of unskilled stokers, and, unfortunately, there are today perhaps more such men employed than at any previous time, as many skilled stokers have joined the army.

There are approximately 45,000 steam plants in Great Britain. Up to the present reports on 364 firms have been carefully scrutinized, and it is estimated that a saving of fully 106,000 tons will result. This saving can be effected without any considerable alteration to the plants by educating the stokers, utilizing the heat in the gases to better advantage, using exhaust steam for heating feed water, adjusting engines to more efficiently use the steam generated, using the hot water from the condenser discharge for boiler-feed purposes instead of cold water, effective lagging of steam pipes and disconnecting steam pipes not in use.

New Westinghouse Research Building

The Westinghouse Electric and Manufacturing Company's New Research Building at East Pittsburgh, Penn., is located about a mile from the works on the Lincoln Highway. It is a plain but substantial building of reinforced concrete and brick.

Provision is made in the new building to deal with a large variety of experiments in many lines of work, including magnetic insulation, metallographic metallurgy, chemistry (organic and inorganic), furnace combustion, woodworking, illumination, glass blowing, etc.

The power house contains motor-generator sets for supplying single-phase, two-phase and three-phase current at 220 volts, and direct current at 250 volts (three-wire circuit). A motor-driven air compressor supplies compressed air at 125 lb. pressure and a large motor-driven vacuum pump supplies the necessary house vacuum. A

liquid air machine capable of supplying 1½ to 2 liters of liquid air per hour is also installed in the main power house. The storage battery is in a separate room in the basement of the power house and consists of a total of 218 cells, so divided that various grouping and combinations may be obtained.

In one end of the basement is the furnace room with a battery of electric furnaces of various types, together with the necessary control for melting, annealing and various metallurgical processes. Stacks are provided at each end of the building, with openings in the basement, for experimental furnaces using fuel, usually natural gas. The woodworking and metal-working shop and storeroom are also in the basement.

On the first and main floor are the main and private offices, the library and the conference room. The remainder of this floor is assigned to physical, electrical and magnetic research. The second floor will be given over to the same general class of work as the first floor. The third floor is devoted to chemical and electrochemical research, illuminating laboratories and a glass-blowing room.

Stoker Manufacturers Association

At a meeting in Cleveland, Ohio, Aug. 1, 1918, an association was formed of the stoker manufacturers of the United States. The principal reason for getting together was to place at the disposal of the Government the entire facilities of the stoker industry to the end that everything possible might be done to help out in the national emergency. Even after the war, however, it is expected that great benefit will be obtained by the association members in the discussion of subjects of interest and value to the stoker industry. Practically all the builders of mechanical stokers are included as charter members of the association. The following officers and executive committee were elected: President, P. Albert Poppenhusen, Chicago, Ill.; vice-president, S. L. Nicholson, East Pittsburgh, Penn.; secretary-treasurer, Fred H. Daniels, Worcester, Mass.; William F. Sauter, Philadelphia, Penn.; W. H. Rea, Detroit, Mich.

The association has been formally elected to membership in the Chamber of Commerce of the United States. A national councilor will be appointed to represent it in the National Chamber, and through this councilor the association will have an opportunity of expressing itself on national questions under discussion by the Federal authorities.

Through its War Service Committee the association has tendered to the Federal Government the entire resources and services of its members, and the committee is working with the Fuel Administration and the War Industries Board for the conservation of fuel, labor and raw materials.

The United States School Garden Army

Among the organizations that have been doing effective yet unostentatious work of a patriotic nature is the army of a million and a half of school children who have been converting thousands of acres of unimproved land into productive gardens.

The benefits derived from this particular activity are numerous and widely distributed. The supply of foodstuffs has been increased, and a corresponding acreage of truck gardens has been released for war purposes. Moreover, these gardens have been located in vacant lots all over the country, so that the produce obtained from them was already distributed and therefore put no burden on the transportation systems. The children themselves have been strengthened by hours of exercise in the sun and air while cultivating these gardens, and they have learned much that will be of permanent value to them.

The movement has proved so helpful and successful that the President has set aside from the National Security and Defense Appropriation an additional sum of $200,000 to carry on the work for another ten months.

A siphon is a mystery to some, as they cannot see how water can run up hill. It does not. It is forced up the short leg of the siphon tube by the weight of the air and then runs down the long length by gravity. There are no mysteries in nature.—*Marine Engineering.*

Sizes of Anthracite

Commenting on the advisability of consumers mixing smaller sizes of anthracite with that ordinarily used, Mercer P. Moseley, Chief of Conservation, states:

Consumers of anthracite cannot get a full supply of stove and chestnut sizes. The reason is that only 41 per cent. of the anthracite mined comes through the screens in these two favorite sizes. It would be extremely wasteful to break up larger commercial sizes for the purpose of getting more chestnut and stove coal. Half the rebroken coal would be dissolved into pea, buckwheat and dust. Not a pound of anthracite is wasted by the trade.

In anthracite mining, the "run of the mine" is sorted or screened into the various commercial sizes and the results average as follows: Broken and larger sizes, 6 per cent.; egg, 13 per cent.; stove, 18 per cent.; chestnut, 23 per cent.; pea, 9 per cent.; buckwheat No. 1, 13 per cent.; smaller sizes, 18 per cent.

Mine operators do all that is possible to avoid producing too large a proportion of pea and smaller sizes. Some mines yield better results than others, but the figures given are the correct average of eastern Pennsylvania anthracite mines for the first eight months of 1918, and they have varied very little in recent years.

"Daylight Saving" Facts

One and a quarter million tons of coal has been saved during the seven months' operation of the "Daylight Saving" law, according to figures compiled by the United States Fuel Administration. When Congress enacted the law to set the clocks of the nation ahead one hour, beginning on Sunday, Mar. 31, and ending Oct. 27, the Fuel Administration made plans to gather facts from many sources in various sections in order to determine the saving in fuel that might be effected by the operation of the law. Figures from these data have been compiled and from these is made the estimate of the coal saved.

Among the many places that kept close watch on the operation of "daylight saving" very definite facts were obtained from one community of about 1,000,000 population. It was shown that in this one district the saving of coal was 17½ tons per thousand population over the period of seven months. These figures were checked against records obtained from other places in widely separated districts having the same relative conditions, and from the mass of facts thus gathered, the estimate of 1,250,000 tons of coal saved is determined.

Information on file with the Fuel Administration from European countries shows that the "daylight-saving" plan has been found effectual chiefly in the seven longer months.

The expansion of quicklime when wet develops an enormous force, that acts slowly and almost irresistibly, and has long invited use for mechanical purposes. Successful efforts to make use of this force have been noted in a recent issue of *Rock Products*, which describes its efficient use in breaking up heavy brick masonry. Several 12 x 20-ft. piers, 12 ft. high, were situated between similar foundation piers for engines in operation, and it was necessary to remove them without injuring the machinery. Blasting was therefore inadmissible, and hand-cutting and breaking too slow and expensive. The work was acccomplished by drilling 3-in. vertical holes 3 ft. deep and 3 ft. apart in both directions over the entire area of the piers, and filling them within 6 in. of the top with fresh slaked lime, in pieces ½ in. to 1½ in. wide. As soon as the lime was thoroughly wet, the tops of the holes were filled with brick drilling well tamped, and in about 10 minutes cracks started in every direction, and the entire top of the foundation pier was broken into 3-ft. cubes.

In the United Kingdom, a population of 44 millions has about 250 public cold stores, of a total capacity of about 33,000,000 cu.ft. In the United States, a population of 95 millions has nearly 1000 public cold stores, with a total capacity of approximately 200,000,000 cu.ft.—*The Engineer* (London).

New Publications

EFFICIENCY IN THE USE OF OIL FUEL. By J. M. Wadsworth. Published by the Bureau of Mines, Department of the Interior, Washington, D. C. Paper, 5 x 7 in.; 86 pages; 17 illustrations; 4 plates.

Investigations made by the Bureau of Mines show that of the 160,000,000 bbl. of oil fuel burned in the United States in 1917 at least 40,000,000 bbl. was wasted. Because of this enormous waste, the present booklet was prepared, the idea being to put before the firemen of stationary and locomotive boilers information as to the principles of efficient oil burning. It deals with heat transmission and conductivity, apparatus for determining the heating value of oils, their flash points and their viscosities. No attempt is made to show all the various forms of burners and boiler settings for the use of oil fuel. Tables of the properties of steam, specific gravity of oil, corrections for temperature, composition and heat values of oils, factors of evaporation, weight of water per cubic foot at various temperatures and log of test for boiler efficiency are given. It is not in any sense a handbook for the practical man, because it contains no suggestions as to methods of operating oil-burning plants. It is simply a compilation of tables and data that the chief engineer or superintendent would be likely to use. A limited number of free copies have been printed and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

BOILER AND FURNACE TESTING. By Rufus T. Strohm. Published by the Bureau of Conservation, United States Fuel Administration, Washington, D. C. Paper; 6 x 9 in.; 20 pages; 3 illustrations.

This pamphlet forms Engineering Bulletin No. 1 of a series that is being issued by the United States Fuel Administration. The series, when completed, will cover the entire range of power-plant operations, the purpose being to educate engineers and firemen in the matter of economical and efficient management of boilers and engines, to the end that coal and labor may be saved. This particular bulletin is devoted to the subject of boiler and furnace testing with the object of increasing the efficiency. It is written for the man in the boiler room, in simple and clear language and it tells how to carry out a boiler test, describing the arrangement of the necessary apparatus and the methods of obtaining the required data. It shows by an example how to calculate the boiler efficiency from the results obtained in the test, and how to find the cost of making 1000 lb. of steam. Finally, it indicates how the results of a test may be used as a basis for improving the performance of the boiler and points out various ways by which to stop up losses and raise the boiler efficiency. The bulletin is printed for free distribution and may be obtained from the Administrative Engineers of the several states or direct from the Conservation Bureau of the United States Fuel Administration, Washington, D. C.

THE DIESEL ENGINE; ITS FUELS AND ITS USES

The lesson in economy in power production and use which America is forced to learn under war conditions is inclining a larger number of people to consider carefully the claims of the more efficient engines, according to the Bureau of Mines, Department of the Interior. The limits of the peculiar field in which each engine is preëminent constantly change with the fluctuating costs of fuel, labor and investment. The Diesel engine is so far the most efficient mechanical device produced for changing the heat of fuels into power, says the bureau. That the fuel must be in liquid form and, therefore, relatively expensive has been one of the elements that has so far limited its use in competition with power plants starting with solid fuel, but the rise in price of coal and the increasing production of burnable fluids from coal distillation may at any time produce a profound change in these relations. The Bureau of Mines has just issued Bulletin 156, "The Diesel Engine; Its Fuels and Its Uses," by Herbert Haas, which is both informative and readable and contains the facts which the interested reader, both nontechnical and technical, most desires to know. The characteristics of the type, theoretical, mechanical and practical, concerning the engines built in this country, are given. The chapter on fuels desirable for these engines is especially valuable and timely. Copies of this bulletin may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

Obituary

Paul H. Cordes, first lieutenant of Company C, Thirtieth Engineers, was killed in action on Sept. 12 on the Western Front. Lieutenant Cordes was 31 years old. He had been in the employ of the Worthington Company 12 years, for the last five years holding the position of sales engineer in the Chicago office. His death will be regretted by his many friends and by his employers in civil life, who speak very highly of his loyal and efficient service.

Personals

H. W. Knott, who for some months has been acting as chief of field organization of the United States Fuel Administration, has resigned.

Charles E. Stuart, who has been connected with the Fuel Administration in charge of the Power and Light Section, has severed that connection to become chief of the Power Section of the Bureau of Production.

Arturo R. Calvo, for the past five years manager of sales of the Permutit Co., has resigned to become an officer and director of the Hercules Engineering Corp. and its affiliated interests, the Electrolytic Engineering Corp. and the Technical Products Co.

A. M. Brown has been appointed district manager of sales of the Chicago Pneumatic Tool Co., with offices at 1740 Market St., Philadelphia, succeeding G. A. Barden, who will remain in Philadelphia as the company's sales representative. Mr. Brown was formerly at the company's New York office as assistant manager of the compressor sales division.

Engineering Affairs

The New England Water Works Association will hold a meeting at the Hotel Brunswick, Copley Square, Boston, Mass., Nov. 13.

The Master Steam and Hot Water Fitters' Association of the State of New York changed its name on Nov. 1 and will hereafter be known as the Heating and Piping Contractors' New York State Association, Inc.

The American Society of Mechanical Engineers and the American Society of Civil Engineers are planning to hold a joint meeting at the Engineering Societies' Building, 29 West 39th St., New York City, on Nov. 20. The topic will be on "The Conservation of Steel." A buffet supper will probably precede the meeting.

Jersey City Association, No. 1, N. A. S. E., on Nov. 16, will extend to National Vice President John Calahan congratulations on his advancement to his present office, and an invitation is extended to the members of all subordinate associations to be present. The affair will be held at the meeting rooms of the association, 538 Summit Ave., Five Corners, Jersey City, N. J., 8 p. m.

Miscellaneous News

The Oklahoma Gas, Electric and Street Railway Association and the **Oklahoma Public Utilities Bureau** were a few days ago merged into the **Oklahoma Utilities Association.** The officers are: President, J. F. Owens, general manager Oklahoma Gas and Electric Co., Oklahoma City, Okla.; first vice president, C. S. Thompson, manager Shawnee Gas and Electric Co., Shawnee, Okla.; second vice president, J. W. Shartel, manager Oklahoma Railways Co., Oklahoma City, Okla.; treasurer, William Mee, president Security National Bank, Oklahoma City, Okla.; secretary, H. A. Lane, 1611 State National Bank, Oklahoma City, Okla.; secretary-assistant, Prof. F. G. Tappan, University of Oklahoma, Norman, Oklahoma, Feb. 13, 14 and 15 were selected for the first annual meeting, which will be held in Oklahoma City.

Business Items

The Cliff Electrical Distributing Co., The Niagara Falls Power Co., and the **Hydraulic Power Co.** of Niagara Falls have been consolidated by agreement effective on Oct. 31, under the name of the Niagara Falls Power Co., Niagara Falls, N. Y.

The Files Engineering Co., Inc., recently received an order from one of the principal oil refineries for 110 Files hand stokers, to be used in connection with stills and power boilers.

Trade Catalogs

Kieley & Mueller, Inc., New York City, have just issued their catalog No. 27. This supersedes all previous "Kieley" catalogs and covers in its 316 pages the complete line of the company's products.

The Vigilant Feed Water Regulator. The Chaplin-Fulton Manufacturing Co., Pittsburgh, Penn. Pages 52, 6 x 9 in. The company's full line of steam specialties for 1919 fully described.

Lagonda Boiler Tube Cleaners. The Lagonda Manufacturing Co., Springfield, Ohio. Catalog X-4. Pages 40, 6¾ x 10 in. A general catalog giving full description of the company's tube cleaners, cleaner accessories and other boiler-room specialties. Copy free upon request.

The Lagonda Multiple Filtration Feed Water Filter and Grease Extractor. The Lagonda Manufacturing Co., Springfield, Ohio. This 12-page "Catalog R" describes the company's multiple-filtration feed-water filter and grease extractor and shows photographs of these extractors installed in various positions in power plants throughout the country. Copy free upon request.

New Construction

PROPOSED WORK

Mass., Chatham—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build a boiler house here. Estimated cost, $30,000. C. W. Parks, Chief.

Mass., Hingham—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build a 2,000,000-gallon tank, pump house and pump piping in connection with the fire protection system to be installed here. Total estimated cost, $200,000.

Conn., Stamford—The Waterside Mills, Pacific St., plans to rebuild its power plant recently damaged by fire. Estimated cost, $50,000. Address F. B. Gillespie.

N. Y., Amsterdam—The Schenectady Illuminating Co., 511 State St., Schenectady, has applied to the Public Service Commission, Albany, for permission to construct an electric-light plant here.

N. Y., Brooklyn—The Brooklyn Eye & Ear Hospital, Schermerhorn St., will install a steam heating system in the proposed 7 story, 50 x 110 ft. hospital which it will build. Total estimated cost, $250,000.

N. Y., New York—The Western Union Telegraph Co., 16 Dey St., will install a steam heating system in the 7 story, 50 x 100 ft. office building which it will build at 38-40 Broad St. Total estimated cost, $300,000.

N. J., Camden—The John H. Mathis Co. plans to build a 1 story, 38 x 39 ft. boiler plant at its shipbuilding works on Front and Erie St.

N. J., Elizabeth—The Elizabeth General Hospital, East Jersey St., will install a steam heating system in the proposed 6 story hospital which it will build. Total estimated cost, $500,000. Crow, Lewis & Wickenhoefer, 200 5th Ave., New York City., N. Y., Arch.

Penn., Crayland (Portland Mills P. O.)—The Construction Division of the War Department, Washington, D. C., has awarded the contract for the construction of a 2 story manufacturing plant here, to the Cleveland Construction Co., Citizens Bldg., Cleveland, Ohio; a steam heating system will be installed in same. Total estimated cost, $2,000,000.

Penn., Harriman—The Merchants Shipbuilding Co., Bristol, plans to build an electric power plant at its yards here.

Penn., Sharon—The Savage Arms Corporation, 50 Church St., New York City, N. Y., plans to build a 1 story, 88 x 88 ft. power plant here.

Md., Baltimore—The C. A. Gambrill Manufacturing Co., 110 Commerce St., plans to build an addition to its boiler house.

Va., Roanoke—W. D. Hardy, 728 Tazewell Ave., is in the market for electric motors and grist-mill machinery.

Ala., Wadley—The Carbon Mountain Lumber Co. is in the market for a 125 hp. boiler and an 85 hp. engine, etc.

Ky., Elizabethtown—The City Council plans to install an additional motor in its pumping station.

Ky., Louisville—Tuck & Co., 1113 West Main St., plans to install additional boilers in its power house.

Ohio, Cleveland—The McClellan File Co., 2344 Hamilton Ave., will install a steam heating system in the proposed 3 story, 70 x 135 ft. factory which it will build. Total estimated cost, $125,000. Briggs & Nelson, 669 Rose Building, Arch.

Wis., Birnamwood—The city is in the market for a new or second hand 80 to 90 ft. tower and 40,000 to 50,000 gal. tank, also a 15 hp. gasoline engine and 150 gal. pump.

Mich., Detroit—The Denby Motor Truck Co. plans to build a 1 story, 40 x 50 ft. boiler house on Holbrook Ave. Estimated cost, $10,000.

Wis., Green Bay—The Northern Paper Mills, Madison and Day St., plan to build a power plant. E. S. Wagner, Mgr.

Minn., Virginia—The city plans to build a 1 story, 30 x 30 ft. power house addition. A. E. Bickford, Clk.

Mo., St. Louis—The city plans an election Nov. 8 to vote on bond issue of $15,000 for the construction of a new lighting plant.

Mo., St. Louis—The Laclede Gas Light Co., Munition Department, 1268 Russell St., will install a heating plant, in connection with the shell maufacturing plant which it will erect. Total estimated cost, $3,830,300.

Ark., Cotter—The Dixie Dam & Power Co. plans to construct a hydro-electric plant.

Ark., Fayetteville—The city plans to install an electrically driven pump at White River pumping station. Estimated cost, $6,000. Address the Mayor.

Ark., Havana—Kyle & Co. plans to install an electric light plant to supply city lighting.

Ark., Waldron—The Crutchfield Lumber Co. is in the market for sawmill and power plant equipment. Estimated cost, $50,000. J. S. Hill, Pres.

Tex., Clifton—The Clifton Ice & Cold Storage Co. plans to build an ice and cold storage plant. Estimated cost, $10,500. A. S. Bookner is interested.

Tex., Ft. Sam Houston—The Construction Division of the War Department, Washington, D. C., plans to build a central steam heating plant here. Estimated cost, $101,000.

Tex., Waco—J. B. Earel, 119 North 9th St., and J. S. Harrison, 25th and Ethel St., is in the market for a 50 hp. engine and a 10 in. centrifugal pump to be installed on the Brazos River to irrigate 234 acres.

Colo., Colorado Springs—The Commissioners of El Paso County plan to build a power plant, including a heating system, to be installed in the court house.

Utah, Salt Lake City—Major A. J. MacDonald will soon receive bids for the installation of a heating system in the proposed hospital unit which will be erected at Ft. Douglas.

Wash., Puget Sound (Bremerton P. O.)—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until Dec. 2 for power plant improvements here; Specification No. 3298.

Ont., Dunville—The Chronicle is in the market for a ¼ and ½ hp., one 10 or 20 volt, 25 cycle, single phase, A.C. motors.

Sask., Eyebrow—Carlyle & Seeley plan to build an electric light plant.

CONTRACTS AWARDED

Conn., New London—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for installing a heating system in the State Pier barracks and mess hall, to Ingalls & Kendrickson, 47 Bowker St., Boston, Mass. Estimated cost, $44,965. Noted Nov. 5.

Conn., Shelton—Sidney Blumenthal & Co., Inc., will build a 1 story, 90 x 130 ft. power plant on Howe St. Estimated cost, $35,000. Noted Oct. 22.

Penn., Philadelphia—Vaughn & Sons Co., Harris St. and Delaware Ave., has awarded the contract for the construction of a 2 story, 46 x 638 ft. boiler house, to Charles L. Stockhausen, Marine Bank Bldg., Baltimore, Md. Estimated cost, $20,000.

Penn., Throop—The Price-Pancoast Coal Co., Scranton, has awarded the contract for the construction of a 1 story, 80 x 100 ft. electric power plant here, to Salvatore Palumbo, Real Estate Exchange Bldg. Estimated cost, $75,000.

Penn., Titusville—The Cyclops Steel Co. will build a 1 story, 46 x 50 ft. boiler house. John Autil, Supt.

Md., Indian Head—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the installation of boilers, superheaters, etc., in the nitrate plant here, to the Edge Moore Iron Co., Edge Moore, Del. Estimated cost, $194,850. Noted July 30.

Va., Hampton Roads—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a boiler plant and heating and steam distributing system, to J. Gill & Sons Co., 1301 Citizens Bldg., Cleveland, Ohio; sub-contract awarded to M. A. Dane & Son, 6 Portland St., Boston, Mass. Estimated cost, $1,000,000.

Va., Norfolk—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing electric lighting and power system in steel storage building, from Conner Electric Co., 258 Washington St., Boston, Mass., $9570, (80 days); H. Alexander, Inc., 20 West 34th St., New York City, N. Y., $9700 (60 days); Hixon Electric Co., 246 Summer St., Boston, Mass., $10,500 (90 days).

Mich., Detroit—The Board of Water Commissioners received bids for building and delivering f.o.b. cars at Detroit waterworks pumping station, 1 horizontal motor driven centrifugal pumping unit, having a capacity of 70,000 gal. per minute and 1 with 45,000 gal. capacity per minute, from the Allis-Chalmers Manufacturing Co., West Allis, Milwaukee, Wis., $53,000; De Laval Steam Turbine Co., West Clinton St., and Pennsylvania R. R., Trenton, N. J., $53,250.

Mich., New Buffalo—The Pere Marquette R. R., Union Station, Detroit, has awarded the contract for the construction of 16 stall roundhouse, to H. R. Snyder & Son, Battle Creek, Mich. Estimated cost, $50,000. The company is in the market for a boiler for heating purposes.

Ill., Chicago—The Amalgamated Machine Corp., 72 West Adams St., has awarded the contract for the construction of a 1 story, 30 x 45 ft. boiler house, to E. W. Sproul Co., 1720 West 35th. Estimated cost, $30,000.

Wis., Altoona—The city has awarded the contract for improvements to waterworks, to A. Lavson & Co., Eau Claire, and is in the market for an electrically driven deep well pump. Estimated cost $33,334.

Wis., Osceola—The Osceola Milling Co. has awarded the contract for the construction of a 4 story, 37 x 87 ft. power plant and mill, to the Milford Manufacturing Co., 303 South 3rd St., Minneapolis, Minn.

Wis., Racine—The Hamilton-Beach Manufacturing Co., Rapids Drive, is building a 3 story, 80 x 150 ft. factory addition to be used for the manufacture of small electric motors and motor driven appliances.

Ariz., Phoenix—The Salt River Valley Water Users Association has awarded the contract for furnishing about 45 pumps for wells, to Layne & Bowler Co., 900 Santa Fe Ave., Los Angeles, Cal. Noted Oct. 15.

WASHINGTON, D. C.

The Bureau of Supplies & Accounts, Navy Department, will soon receive bids for furnishing equipment as follows:

Schedule No. 6878½, two sets of motor generators, delivery Washington, D. C.

Schedule No. 6879½, four turbo-generators, delivery Brooklyn, N. Y.

Schedule No. 6883½, three 1 hp. motors, delivery Boston, Mass.

Schedule No. 6821½, 14 motor driven hacksaws, delivery Brooklyn, N. Y.

The Bureau of Supplies & Accounts, Navy Department, will receive bids for furnishing equipment as follows:

Nov. 22, Schedule No. 6912½, generators, delivery f.o.b. Washington.

Nov. 22, Schedule No. 6932½, miscellaneous generator motors, delivery Norfolk, Va.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck.	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene.			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10, other rates p. 95.